Tab B, No. 6
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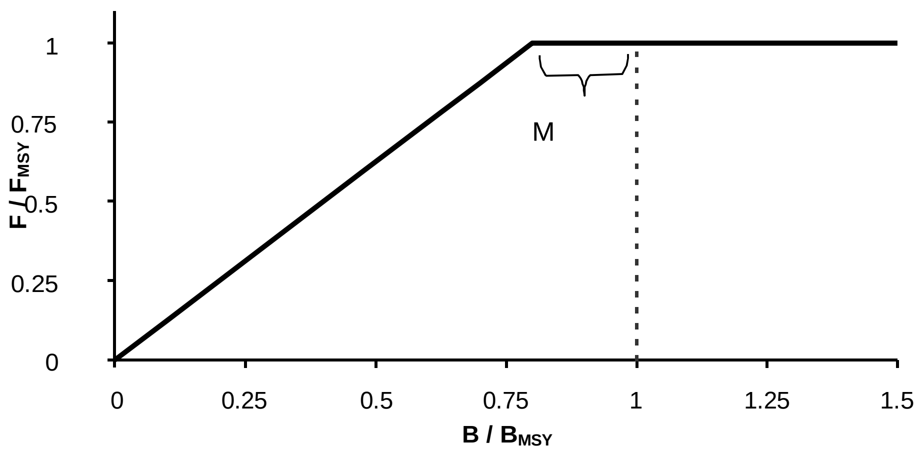
Minimum Stock Size Threshold (MSST) for Reef Fish Stocks



Draft Amendment 44

to the Fishery Management Plan for the Reef Fish Resources of the Gulf of Mexico

January 2017

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ENVIRONMENTAL ASSESSMENT COVER SHEET

Name of Action

Draft Amendment 44 to the Fishery Management Plan for the Reef Fish Resources of the Gulf of Mexico: Minimum Stock Size Threshold (MSST) for Reef Fish Stocks

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Type of Action

( ) Administrative	( ) Legislative
(X) Draft	( ) Final

Summary/Abstract

ABBREVIATIONS USED IN THIS DOCUMENT

ACL	annual catch limit
ALS	Accumulated Landings System
AM	accountability measure
Council	Gulf of Mexico Fishery Management Council
CS	consumer surplus
EEZ	Exclusive Economic Zone
EFH	essential fish habitat
EIS	Economic Impact Statement
EJ	environmental justice
ELMRP	Estuarine Living Marine Resources Program
ESA	Endangered Species Act
FMP	fishery management plan
FMU	fishery management unit
FTE	full time equivalent
GMFMC	Gulf of Mexico Fishery Management Council
Gulf	Gulf of Mexico
IFQ	individual fishing quota
IPCC	Intergovernmental Panel on Climate Change
LAPP	limited access privilege program
M	instantaneous rate of natural mortality
Magnuson Stevens Act	Magnuson Stevens Fishery Conservation and Management Act
MFMT	maximum fishing mortality threshold
MMPA	Marine Mammal Protection Act
MRFSS	Marine Recreational Fisheries Statistics Survey
MRIP	Marine Recreational Information Program
MSST	minimum stock size threshold
MSY	maximum sustainable yield
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOR	net operating revenue
NOS	National Ocean Service
NS1	National Standard 1 guidelines
OY	optimum yield
PDARP	Programmatic Damage Assessment and Restoration Plan
PS	producer surplus
RFFA	reasonably foreseeable future action
SDC	status determination criteria
SEAMAP	Southeast Area Monitoring and Assessment Program
Secretary	Secretary of Commerce
SEDAR	Southeast Data, Assessment and Review
SEFSC	Southeast Fisheries Science Center
SERO	Southeast Regional Office
SPR	spawning potential ratio
SRHS	NMFS Southeast Region Headboat Survey

SSC	Science and Statistical Committee
USFWS	United States Fish and Wildlife Service

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CHAPTER 1. INTRODUCTION

1.1 Background

The Sustainable Fisheries Act of 1996 and the subsequent revisions to the National Standard 1 (NS1) guidelines required Councils to establish new definitions of overfishing (maximum fishing mortality threshold – MFMT), overfished (minimum stock size threshold –MSST), and estimates of maximum sustainable yield (MSY) or proxy for managed stocks. Collectively, these are referred to as status determination criteria (SDC). In 1999, the Gulf of Mexico Fishery Management Council (Council) submitted the Generic Sustainable Fisheries Act Amendment (GMFMC 1999) to comply with these requirements. All of the MFMT criteria and proxies for MSY were in terms of percent spawning potential ratio (SPR), while the proposed MSST criteria were deferred until further evaluations of the stocks could occur. The National Marine Fisheries Service (NMFS) accepted most of the MFMT definitions, but rejected all of the definitions for MSY and other biomass reference points on the basis that SPR is not biomass-based and is therefore not an acceptable proxy for MSY or MSST.

The Council subsequently established SDC on a species-by-species basis as stock assessments were conducted. However, SDC were only defined if a stock was in need of rebuilding, as part of the parameters of the rebuilding plan. Of the 31 species currently in the Reef Fish Fishery Management Plan (FMP), 14 have had stock assessments conducted (Table 2.1.2), but only 6 have had MSST and MSY proxies defined (Table 1.2), leaving 25 reef fish stocks with undefined MSY and MSST values. All of the reef fish stocks have MFMT defined since those were accepted in the Sustainable Fisheries Act Amendment, although in some cases the MFMT was redefined in a later amendment.

For most stocks in the Gulf, the overfished status has been evaluated using the formula:

MSY

Maximum Sustainable Yield is the largest amount of fish that can be harvested on a continuing basis. The true value for MSY is often not known, so a proxy is usually used, such as the yield when fishing at $F_{30\%\ SPR}$.

MFMT

Maximum Fishing Mortality Threshold is the highest fishing mortality rate allowed. It is usually set to the rate corresponding to harvesting the maximum sustainable yield (F_{MSY}). A proxy such as $F_{30\%\ SPR}$ is often used when the true MSY and corresponding F_{MSY} are not known. Fishing at a rate higher than MFMT constitutes overfishing and can lead to stock declining.

MSST

Minimum Stock Size Threshold is a stock biomass level below which the stock is considered to be overfished and in need of a rebuilding plan. It is usually set below the stock level that can support maximum sustainable yield or its proxy, but no more than 50% below.

$(1-M) * B_{MSY}$, or 50% of B_{MSY}, whichever is less

In the above equation, M is the natural mortality rate and B_{MSY} (sometimes referred to as spawning stock biomass, SSB_{MSY}[1]) is the stock biomass level that allows the stock to produce MSY (or its proxy) on a continuing basis. The lowest level of MSST allowed under the National Standard guidelines is 50% of B_{MSY}. As noted above, the MSST has only been formally defined on an as needed basis, so for most stocks the overfished status determination has been an informal determination. One purpose of this amendment is to adopt definitions of MSST for all reef fish stocks, consistent with the NS1 guidelines (81 FR 71858; http://www.nmfs.noaa.gov/sfa/laws_policies/national_standards/ns1_revisions.html).

For some stocks that have a very low natural mortality rate, the formula $(1-M) * B_{MSY}$ results in an MSST that is very close to the B_{MSY} biomass level. For example, red snapper is a moderately long-lived fish that has a natural mortality rate of about 0.1. Using the above formula, this results in a MSST at 90% of B_{MSY}. In such situations it can be difficult to determine if a stock is actually below MSST due to imprecision and accuracy of the data. In addition, natural fluctuations in stock biomass levels around the B_{MSY} level may temporarily drop the spawning stock biomass below MSST. Setting a wider buffer between $B_{MSY\ (or\ proxy)}$ and MSST can avoid these issues.

Setting MSST at a lower level reduces the likelihood of a stock being declared overfished, and may reduce the time needed for an overfished stock to rebuild back above the MSST. However, while rebuilding to above the MSST allows a stock to be re-characterized from overfished to rebuilding, it does not relieve the requirement that the stock be rebuilt to B_{MSY} within a specified time period.

1.2 Purpose and Need

The purpose for the action is to establish MSST for all stocks in the reef fish fishery management unit.

The need for the proposed action is to comply with the NS1 guidelines requiring that stocks have an MSST.

[1] Assessment reports frequently refer to adult biomass levels (B) as pawning stock biomass (SSB). For consistency, this amendment will use the term B to refer to biomass even when the source document refers to SSB.

Gulf of Mexico Fishery Management Council

- Responsible for conservation and management of fish stocks
- Consists of 17 voting members, 11 of whom are appointed by the Secretary of Commerce, the National Marine Fisheries Service Regional Administrator, and 1 representative from each of the 5 Gulf states marine resource agencies
- Responsible for developing fishery management plans and amendments, and for recommending actions to National Marine Fisheries Service for implementation

National Marine Fisheries Service

- Responsible for conservation and management of fish stocks
- Responsible for compliance with federal, state, and local laws
- Approves, disapproves, or partially approves Council recommendations
- Implements regulations

1.3 History of Management

Following passage of the Sustainable Fisheries Act of 1996, NMFS published updated NS1 Guidelines that included the introduction of status determination criteria. The updated guidelines for NS1 described MFMT to determine when overfishing is occurring, and MSST to determine when a stock is overfished. The NS1 guidelines further required that each FMP must specify, to the extent possible, objective and measurable status determination criteria for each stock or stock complex covered by that FMP and provide an analysis of how the status determination criteria were chosen and how they relate to reproductive potential.

In 1999, the Council submitted its Generic Sustainable Fisheries Act Amendment (GMFMC 1999), in which it attempted to define MFMT along with other biological reference points of MSY and optimum yield (OY) for stocks under management. All of the definitions were based on static SPR [2]. For reef fish stocks, the amendment proposed the following MFMT MSY, OY, and MSST definitions provided in Table 1.1.

[2] SPR is a measure of reproductive capability, but is measured in two different ways. Static SPR is a measure of spawning-per-recruit relative to the level of spawning-per recruit that would occur in the absence of fishing. It is analogous to yield-per-recruit and is the level of spawning that would occur at equilibrium if fishing occurred at the same rate and selectivity pattern. Transitional SPR is a measure of spawning production per recruit in a given year relative to the spawning production that would have occurred in that year if there had been no fishing. Static SPR is directly related to fishing mortality and can be used as a measure of overfishing. Transitional SPR can be used to indicate how close the age structure of a stock is to being rebuilt, but does not necessarily correlate to absolute biomass levels (GMFMC 1996). Although these terms have fallen out of common use, phrases such as "a mortality rate of 30% SPR" or "yield when fishing at 30% SPR" refer to static SPR.

Table. 1.1. Proposed MSY, OY, MFMT, and MSST definitions in the Generic Sustainable Fisheries Amendment. The MFMT definitions were approved except for red snapper (which was defined in a later amendment), but all SPR-based biomass reference points (MSY, OY, and MSST) were disapproved.

Stock	MSY (proposed, not approved)	OY (proposed, not approved)	MFMT (approved)	MSST
Goliath grouper	50% static SPR	50% static SPR	$F_{50\%\ SPR}$	To be implemented by framework measure as estimates of B_{MSY} and MSST are developed by NMFS, the Reef Fish Stock Assessment Panel, and the Council.
Red snapper	26% static SPR	36% static SPR	$F_{26\%\ SPR}$	
All other reef fish stocks	30% static SPR	40% static SPR	$F_{30\%\ SPR}$	

On November 17, 1999, NMFS notified the Council that, while it approved the definitions of MFMT based on static SPR, it disapproved all SPRs submitted as proxies for MSY, OY, and MSST because SPR is not biomass-based and is not an acceptable proxy for biomass reference points.

All stocks have an MFMT from the Generic Sustainable Fisheries Act Amendment or as later modified. Other status determination criteria and biological reference points were specified on a stock-by-stock basis as stocks were assessed, but only if the stock was determined to be in need of a rebuilding plan. Stocks for which MSST has been specified are shown in Table 1.2.

Table 1.2. Stocks with status determination criteria assigned.

Stock	MFMT	MSST	MSY	Source
Gag	F_{MAX}	(1-M)*female B_{MAX} (M = 0.15)	Yield at B_{MAX}	Amendment 30B (GMFMC 2008c)
Red grouper	$F_{30\%\ SPR}$	(1-M)* SSfemale gonad wt_{MSY} (M = 0.2)	Yield at $B_{30\%\ SPR}$ measured in terms of female gonad weight	Secretarial Amendment 1 (GMFMC 2004a)
Red snapper	$F_{26\%\ SPR}$	(1-M)*B_{MSY} (M = 0.094277)	Yield at $F_{26\%\ SPR}$	Amendment 27 (GMFMC 2007)
Vermilion snapper	F_{MSY} (no proxy)	(1-M)*B_{MSY} (M = 0.25)	Yield at F_{MSY}	Amendment 23 (GMFMC 2004c)
Gray triggerfish	$F_{30\%\ SPR}$	(1-M)*egg$B_{30\%\ SPR}$ (M = 0.27)	Yield at $B_{30\%\ SPR}$ measured in terms of female egg production	Amendment 30A (GMFMC 2008b)
Greater amberjack	$F_{30\%\ SPR}$	(1-M)*B_{MSY} (M = 0.28)	Yield at $F_{30\%\ SPR}$	Secretarial Amendment 2 (GMFMC 2002)
Hogfish (proposed)	$F_{30\%\ SPR}$	0.75*$B_{30\%\ SPR}$	Yield at $B_{30\%\ SPR}$	Amendment 43 (in development)

Note: Amendment 23 did not define an MSY proxy for vermilion snapper. It specified that status determination criteria were to be based on the actual MSY estimate. The SEDAR 9 and SEDAR 9 update assessments, however, used a proxy based on the yield when fishing at $F_{30\%\ SPR}$.

Several other reef fish species have had stock assessments, but were not in need of rebuilding plans (or in the case of goliath grouper, harvest was already prohibited), and therefore status determination criteria were not specified. These stocks include mutton snapper, lane snapper, yellowedge grouper, goliath grouper, black grouper, tilefish, and hogfish. Status determination criteria for hogfish have been proposed in Amendment 43, which has been submitted to NMFS and is currently under review.

CHAPTER 2. MANAGEMENT ALTERNATIVES

2.1 Action 1 –Minimum Stock Size Threshold (MSST) for Species in the Reef Fish Fishery Management Unit

Alternative 1: No Action. MSST for species that have a defined specification will not be changed. MSST will remain undefined for species that do not have a definition specified until specified on a stock-by stock basis.

Alternative 2: For all reef fish stocks MSST = (1-M)*$B_{MSY\ (or\ proxy)}$.

Alternative 3: For all reef fish stocks MSST = (1-M) *$B_{MSY\ (or\ proxy)}$ or 0.75*$B_{MSY\ (or\ proxy)}$, whichever provides a larger buffer between MSST and $B_{MSY\ (or\ proxy)}$.

Alternative 4: For all reef fish stocks MSST = 0.75*$B_{MSY\ (or\ proxy)}$.

Alternative 5: For all reef fish stocks MSST = 0.50*$B_{MSY\ (or\ proxy)}$.

<u>Discussion</u>:

Note: In October 2015, the Gulf of Mexico Fishery Management Council (Council) voted to define MSST for hogfish in Amendment 43, which addresses a redefinition of the hogfish management unit plus related items including status determination criteria for hogfish. Amendment 43 has proposed that the hogfish MSST be set at 0.75 * $B_{MSY\ proxy}$., which is identical to either **Alternative 3** or **Alternative 4** in this action. Amendment 43 is currently under review by the National Marine Fisheries Service (NMFS). The alternatives in this action except for **Alternative 1** are intended to standardize the definition of MSST for all Gulf of Mexico reef fish stocks. Depending upon which alternative is selected in this action, the hogfish MSST definition proposed in Amendment 43 will be modified as follows:

- If the Council selects **Alternative 1** in this section as its preferred alternative, then Amendment 43 will determine the MSST for hogfish.

- If the Council selects **Alternative 3** or **Alternative 4** as its preferred alternative, the MSST proposed in Amendment 43 for hogfish (0.75*$B_{MSY\ (or\ proxy)}$) will remain the same.

- If the Council selects **Alternative 2** or **Alternative 5** as its preferred alternative, this proposed definition will supercede the proposed definition for hogfish in Amendment 43.

MSST is used to determine when a stock is overfished. There are currently three stocks in the Reef Fish Fishery Management Plan (FMP) classified as overfished (red snapper, greater amberjack, and gray triggerfish). All three stocks would remain overfished under all of the alternatives except for **Alternative 5** (Table 2.1.1). Under **Alternative 5**, red snapper and greater amberjack would remain overfished, but gray triggerfish would be reclassified to not overfished but rebuilding. Although no longer classified as overfished, gray triggerfish would continue to be managed under a rebuilding plan until it achieves a spawning stock biomass level that can sustain harvest at maximum sustainable yield (MSY) or proxy on a continuing basis ($B_{MSY\ (or\ proxy)}$).

Table 2.1.1. Overfished status for currently overfished stocks under each alternative.

Stock	$B_{Current}$/ B_{MSY}	Status				
		Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
Red Snapper	37% (SEDAR 31 2013)	Overfished	Overfished	Overfished	Overfished	Overfished
Greater Amberjack	47% (SEDAR 33 2014)	Overfished	Overfished	Overfished	Overfished	Overfished
Gray Triggerfish	54% (SEDAR 43 2015)	Overfished	Overfished	Overfished	Overfished	Rebuilding

When MSST is defined as equal to (1-M)*$B_{MSY\ (or\ proxy)}$ stocks with a low natural mortality rate (M) can end up with an MSST that is only slightly below the $B_{MSY\ (or\ proxy)}$ spawning stock biomass level. In such situations it can be difficult to determine if a stock is actually below MSST due to imprecision and accuracy of the data. In addition, natural fluctuations in stock biomass levels around the B_{MSY} level may temporarily drop the spawning stock biomass below MSST, although analysis from the Southeast Fisheries Science Center (SEFSC) suggests that this is unlikely except at very low natural mortality rates (see below). Setting a wider buffer between $B_{MSY\ (or\ proxy)}$ and MSST can avoid these issues. In addition, setting a wider buffer can allow a greater opportunity for management to end a decline in a stock that is approaching an overfished condition without the constraints imposed by a rebuilding plan that is required if the stock drops below MSST and is declared overfished. However, if a stock does drop below MSST and is declared overfished, a more restrictive rebuilding plan may be needed than if there were a narrower buffer between B_{MSY} and MSST. Thus, the decision of where to set MSST requires a balance between conservation and management flexibility.

Under **Alternative 1**, only six of the 31 stocks in the Reef Fish FMP currently have MSST defined. These six stocks, gag, red grouper, red snapper, vermilion snapper, gray triggerfish, and greater amberjack (Table 1.2), have MSST defined as (1-M)*$B_{MSY\ (or\ proxy)}$. The natural mortality rate (M) for these stocks ranges from 0.09 to 0.25, so the resulting MSST values range from 75% to 91% of the B_{MSY} proxy. In addition, for hogfish, Amendment 43 includes a proposal to define MSST as 0.75 * B_{MSY} proxy. For the remaining 24 stocks, MSST is undefined and would need to be established on a case by case basis.

Alternative 2 sets MSST for all stocks at (1-M)*$B_{MSY\ (or\ proxy)}$. This is often the de facto MSST used to determine overfished status, but has been formally adopted in an FMP amendment only for stocks in need of a rebuilding plan. For hogfish, Amendment 43 proposes MSST as 0.75 * B_{MSY} proxy. The natural mortality rate for hogfish is M = 0.179, so under this alternative the hogfish MSST would change to 0.821 * B_{MSY} proxy, a much narrower buffer. Stocks that have not been assessed, and stocks that have been assessed and found not to be in need of a rebuilding plan, have not had the MSST established. Natural M have been estimated for 14 of the 31 reef fish stocks in the Gulf (Table 2.1.2). These estimates range from a low of 0.073 (yellowedge grouper) to a high of 0.28 (greater amberjack), and the resulting MSST values using this formula range from 72% to 91% of the $B_{MSY\ (or\ proxy)}$. An additional 14 stocks have natural mortality estimates from other regions, either in the published literature or in Southeast Data, Assessment, and Review (SEDAR) assessments done for South Atlantic stocks (Table 2.1.3). The SEFSC and the Scientific and Statistical Committee (SSC) would need to determine if these estimates are applicable to the Gulf stocks or if separate Gulf estimates are needed. Three stocks have no published estimates of natural mortality (Table 2.1.3).

Alternative 3 sets MSST at 0.75*$B_{MSY\ (or\ proxy)}$ for all stocks that have M = 0.25 or less. As a result, all reef fish stocks would have a buffer of at least 0.75*$B_{MSY\ (or\ proxy)}$. Stocks with M greater than 0.25 would use the (1-M)*B_{MSY} formula, which would result in a wider buffer between B_{MSY} and MSST for those stocks with M greater than 0.25. Those stocks that would have MSST defined (or redefined) to 0.75*$B_{MSY\ (or\ proxy)}$ are:

Mutton snapper (M=0.11)	Vermilion snapper (M=0.25)	Black grouper (M=0.136)
Red snapper (M=0.094)	Yellowedge grouper (M=0.073)	Gag (M-0.134)
Lane snapper (M=0.11-0.24)	Goliath grouper (M=0.12)	Tilefish (M=0.13)
Yellowtail snapper (M=0.194)	Red grouper (M=0.14)	Hogfish (M=0.179)

In addition, there are 14 reef fish stocks that have natural mortality rates estimated from regions other than the Gulf and 3 stocks that have no estimate of natural mortality (Table 2.1.3). Until estimates of natural mortality for the Gulf are available, or the SEFSC and SSC determine if natural mortality from other regions are applicable to the Gulf of Mexico, these stocks will be considered to have an unknown mortality in this region and will be included in the low mortality category with MSST = 0.75**$B_{MSY\ (or\ proxy)}$. These stocks include:

Queen snapper (M=0.33-0.843)	Speckled hind (M=0.15-0.20)	Goldface tilefish (M=n/a)
Blackfin snapper (M=0.23-0.73)	Warsaw grouper (M=0.08)	Blueline tilefish (M=0.10)
Cubera snapper (M=0.15)	Snowy grouper (M-0.12)	Lessor amberjack (M=n/a)
Gray snapper (M=0.18-0.43)	Yellowmouth grouper (M=0.14-0.24)	Almaco jack (M=n/a)
Silk snapper (M=0.19-0.86)	Scamp (M=0.14-0.15)	Banded rudderfish (M=0.41)
Wenchman (M=0.44)	Yellowfin grouper (M=0.20)	

Under **Alternative 3**, 29 of the 31 stocks in the Reef Fish FMP would have MSST = 0.75*$B_{MSY\ (or\ proxy)}$. The only stocks not subject to this level are gray triggerfish (M=0.27) and greater amberjack (M-0.28). For these stocks, MSST would be equal to 0.73*B_{MSY} and 0.72*B_{MSY} respectively.

Alternative 4 sets MSST 0.75*$B_{MSY\ (or\ proxy)}$ for all reef fish stocks. This would set MSST at the 0.75 level for all 31 stocks in the FMP including gray triggerfish and greater amberjack.

Alternative 5 sets MSST 0.50*$B_{MSY\ (or\ proxy)}$ for all reef fish stocks. This would set MSST at the 0.50 level for all 31 stocks in the FMP.

If any species are added to the management unit, or if the estimate of natural M is changed in a peer-review report or SEDAR assessment for any existing species in the management unit, the MSST will be adjusted based on the most recent estimate of M if applicable under the preferred alternative selected in this action.

Evaluation of the Likelihood of Stocks Falling Below MSST Due to Natural Fluctuations

The SEFSC evaluated the probability that spawning stock biomass will fall below the MSST in the absence of overfishing when MSST = (1-M)*B_{MFMT} versus other MSST reference points (Appendix C). This analysis was requested by the interdisciplinary planning team during preparation of this amendment. The analysis modeled three stocks using different proxies for minimum fishing mortality threshold (MFMT) (F_{MSY} for bluefin tuna, F_{MAX} for vermilion snapper, and $F_{30\% SPR}$ for gray triggerfish). For these stocks, estimated M ranged from 0.14 to 0.27. In the model, abundance was varied randomly while the stock was fished at MFMT. Results showed that fewer than 5% of the model runs resulted in spawning stock levels below MSST at either (1-M)*B_{MFMT} or 0.75*B_{MSY}. None of the model runs resulted in spawning stock levels below MSST at 0.50*B_{MSY}. These results indicate that for the stocks examined, (1-M)*B_{MFMT} appears to be a sufficient buffer against stocks dropping below MSST due to natural fluctuations. However, lower values of M did result in higher probabilities of the stock dropping below MSST despite not experiencing overfishing. As a result, the relationship may breakdown for very small levels of M less than 0.1.

Table 2.1.2. Reef fish species with natural mortality estimates from stock assessments for the Gulf of Mexico stocks.

Common Name	Scientific Name	M	Source
	Snappers		
Mutton snapper	*Lutjanus analis*	0.11	SEDAR 15A (2008)
Red snapper	*Lutjanus campechanus*	0.094277	SEDAR 31 (2013)
Lane snapper*	*Lutjanus synagris*	0.30 0.11-0.24	Ault et al. (2005) Johnson et al. (1995)
Yellowtail snapper	*Ocyurus chrysurus*	0.194	O'Hop et al. (2012)
Vermilion snapper	*Rhomboplites aurorubens*	0.25	SEDAR 9 (2006c)
	Groupers		
Yellowedge grouper	*Hyporthodus flavolimbatus*	0.073	SEDAR 22 (2011a)
Goliath grouper	*Epinephelus itajara*	0.12	SEDAR 23 (2011b)
Red grouper	*Epinephelus morio*	0.14	SEDAR 12 (2007)
Black grouper	*Mycteroperca bonaci*	0.136	SEDAR 19 (2010)
Gag	*Mycteroperca microlepis*	0.134	SEDAR 33 (2014a)
	Tilefishes		
Tilefish	*Lopholatilus chamaeleonticeps*	0.13	SEDAR 22 (2011c)
	Other Species		
Hogfish	*Lachnolaimus maximus*	0.179	Cooper et al. (2013)
Greater amberjack	*Seriola dumerili*	0.28	SEDAR 33 (2014b)
Gray triggerfish	*Balistes capriscus*	0.27	SEDAR 9 (2006az)

* Lane snapper: Ault et al. (2005) estimated M=0.30 for lane snapper in the Florida Keys. Johnson et al. (1995) reported a range of M estimates from 0.11 to 0.24 for lane snapper from the northern Gulf of Mexico.

Table 2.1.3. Reef fish species with no estimate of Gulf of Mexico natural mortality. Natural mortality estimates, where shown, are for stocks from other regions, primarily the Florida Keys, U.S. South Atlantic, or Caribbean.

Common Name	Scientific Name	M	Source
	Snappers		
Queen snapper	*Etelis oculatus*	0.843 0.33-0.76	Murray and Moore (1992) Bryan et al. (2011)
Blackfin snapper	*Lutjanus buccanella*	0.23 0.73	Ault et al. (1998) Tabash and Sierra (1996)
Cubera snapper	*Lutjanus cyanopterus*	0.15	Ault et al. (1998)
Gray (mangrove) snapper	*Lutjanus griseus*	0.25 0.18-0.43	Ault et al. (2005) Burton (2000)
Silk snapper	*Lutjanus vivanus*	0.23 0.19-0.86 0.86	Ault et al. (1998) Bryan et al. (2011) Tabash and Sierra (1996)
Wenchman	*Pristipomoides aquilonaris*	0.44	Froese and Pauly (2014a)
	Groupers		
Speckled hind	*Epinephelus drummondhayi*	0.20 0.15	Ault et al. (1998) Ziskin (2008)
Warsaw grouper	*Hyporthodus nigritus*	0.08	Ault et al. (1998)
Snowy grouper	*Hyporthodus niveatus*	0.12	SEDAR 36 (2013)
Yellowmouth grouper	*Mycteroperca interstitialis*	0.14-0.24*	Burton et al. (2014)
Scamp	*Mycteroperca phenax*	0.15 0.14	Potts and Brennan (2001) Ault et al. (2005)
Yellowfin grouper	*Mycteroperca venenosa*	0.20	Ault et al. (2005)
	Tilefishes		
Goldface tilefish	*Caulolatilus chrysops*	n/a	
Blueline tilefish	*Caulolatilus microps*	0.10	SEDAR 32 (2013)
	Jacks		
Lesser amberjack	*Seriola fasciata*	n/a	
Almaco jack	*Seriola rivoliana*	n/a	
Banded rudderfish	*Seriola zonata*	0.41	Froese and Pauly (2014b)

* For yellowmouth grouper, Burton et al. (2013) gave age specific natural mortality rates calculated three ways, but did not provide an average. The values in this table are the range of average values for each method for the adult age groups (ages 3 to 31).

Time to Recover from the Minimum Stock Size Threshold

At the January 2017 SSC meeting, the SEFSC presented an analysis of how long it would take stocks with various life history characteristics to recover to B_{MSY} (or proxy) from MSST levels of 90%, 85%, 75%, and 50% of B_{MSY} (or proxy). The complete report is in Appendix D, and is briefly summarized here. The species selected for analyses were based on having had recent stock assessments and a diversity of life histories, and were as follows (natural mortality rates are from NMFS stock assessments except where noted):

- Yellowfin tuna (M = 0.70)[3]
- Vermilion snapper (M = 0.25)
- Gray triggerfish (M = 0.27)
- Red Snapper (M = 0.09)
- King mackerel (M = 0.17)
- western Atlantic Bluefin tuna (M = 0.14)[4]
- Gag (M = 0.13)
- Yellowedge grouper (M = 0.07)

The analyses projected that, for all species, recovery would occur in 10 years or less under all MSST levels (Table 2.1.4).

Table 2.1.4. Time to recovery from four definitions of MSST in the absence of fishing mortality

MSST Definition: (% B_{MFMT})	Species							
	Yellowfin tuna	Gray Triggerfish	King Mackerel	Vermilion Snapper	Gag Grouper	Red Snapper	Yellowedge Grouper	Bluefin Tuna
90	1	1	1	1	1	1	1	2
85	1	1	1	1	2	1	2	3
75	1	2	2	2	2	2	3	5
50	3	3	3	3	3	4	6	10

However, there is a large amount of uncertainty in the stock-recruit relationship, and in most cases it is impractical to eliminate all sources of fishing mortality. Furthermore, stocks are rarely found to be exactly at the MSST level, and may be substantially below MSST before overfished

[3] Yellowfin tuna natural mortality rate taken from Sculley, Michelle L., "Estimating Movement Rates of Atlantic Ocean Tropical Tunas, Katsuwonus Pelamis, Thunnus Albacares, and T. Obesus, from Tagging Data" (2016). Open Access Dissertations. Paper 1755. http://scholarlyrepository.miami.edu/cgi/viewcontent.cgi?article=2777&context=oa_dissertations

[4] Atlantic blufin tuna natural mortality taken from Fonteneau, A. and J. Maguire. 2014. On the natural mortality of eastern an western Atlantic bluefin tuna. SCRS/2013/077. Collect. Vol. Sci. Pap. ICCAT, 70(1): 289-298. https://www.iccat.int/Documents/CVSP/CV070_2014/n_1/CV070010289.pdf

determinations are made. Consequently, actual recovery rates are likely to take longer than indicated in the analysis. Finally, as shown in Porch (2016) (Appendix C), there is very little chance that spawning potential levels would fall below 75% B_{MSY} unless overfishing had been occurring. Thus, it would seem inconsistent to wait until the stock had decreased to well below 75% of B_{MSY} to declare it overfished.

CHAPTER 3. AFFECTED ENVIRONMENT

3.1 Description of the Physical Environment

The Gulf of Mexico (Gulf) has a total area of approximately 600,000 square miles (1.5 million km^2), including state waters (Gore 1992). It is a semi-enclosed, oceanic basin connected to the Atlantic Ocean by the Straits of Florida and to the Caribbean Sea by the Yucatan Channel (Figure 3.1.1). Oceanographic conditions are affected by the Loop Current, discharge of freshwater into the northern Gulf, and a semi-permanent, anti-cyclonic gyre in the western Gulf. The Gulf includes both temperate and tropical waters (McEachran and Fechhelm 2005). Gulf water temperatures range from 54º F to 84º F (12º C to 29º C) depending on time of year and depth of water. Mean annual sea surface temperatures ranged from 73 º F through 83º F (23-28º C) including bays and bayous (Figure 3.1.1) between 1982 and 2009, according to satellite-derived measurements (NODC 2011: http://accession.nodc.noaa.gov/0072888). In general, mean sea surface temperature increases from north to south with large seasonal variations in shallow waters.

The physical environment for Gulf reef fish is also detailed in the final environmental impact statements (EIS) for the Generic Essential Fish Habitat (EFH) Amendment, the Generic Annual Catch Limits/Accountability Measures (ACL/AM) Amendment, and Reef Fish Amendment 40 (refer to GMFMC 2004a; GMFMC 2011a; GMFMC 2014) and are incorporated by reference and further summarized below. In general, reef fish are widely distributed in the Gulf, occupying both pelagic and benthic habitats during their life cycle (Appendix B). A planktonic larval stage lives in the water column and feeds on zooplankton and phytoplankton (GMFMC 2004a). Juvenile and adult reef fish are typically demersal and usually associated with bottom topographies on the continental shelf (less than 100m) which have high relief, i.e., coral reefs, artificial reefs, rocky hard-bottom substrates, ledges and caves, sloping soft-bottom areas, and limestone outcroppings. However, several species are found over sand and soft-bottom substrates. For example, juvenile red snapper are common on mud bottoms in the northern Gulf, particularly off Texas through Alabama. Also, some juvenile snapper (e.g. mutton, gray, red, dog, lane, and yellowtail snappers) and grouper (e.g. Goliath grouper, red, gag, and yellowfin groupers) have been documented in inshore seagrass beds, mangrove estuaries, lagoons, and larger bay systems.

With respect to the National Register of Historic Places, there is one site listed in the Gulf. This is the wreck of the *U.S.S. Hatteras*, located in federal waters off Texas. Historical research indicates that over 2,000 ships have sunk on the Federal Outer Continental Shelf in the Gulf between 1625 and 1951; thousands more have sunk closer to shore in state waters during the same period. Only a handful of these have been scientifically excavated by archaeologists for the benefit of generations to come. Further information can be found at: http://www.boem.gov/Environmental-Stewardship/Archaeology/Shipwrecks.aspx.

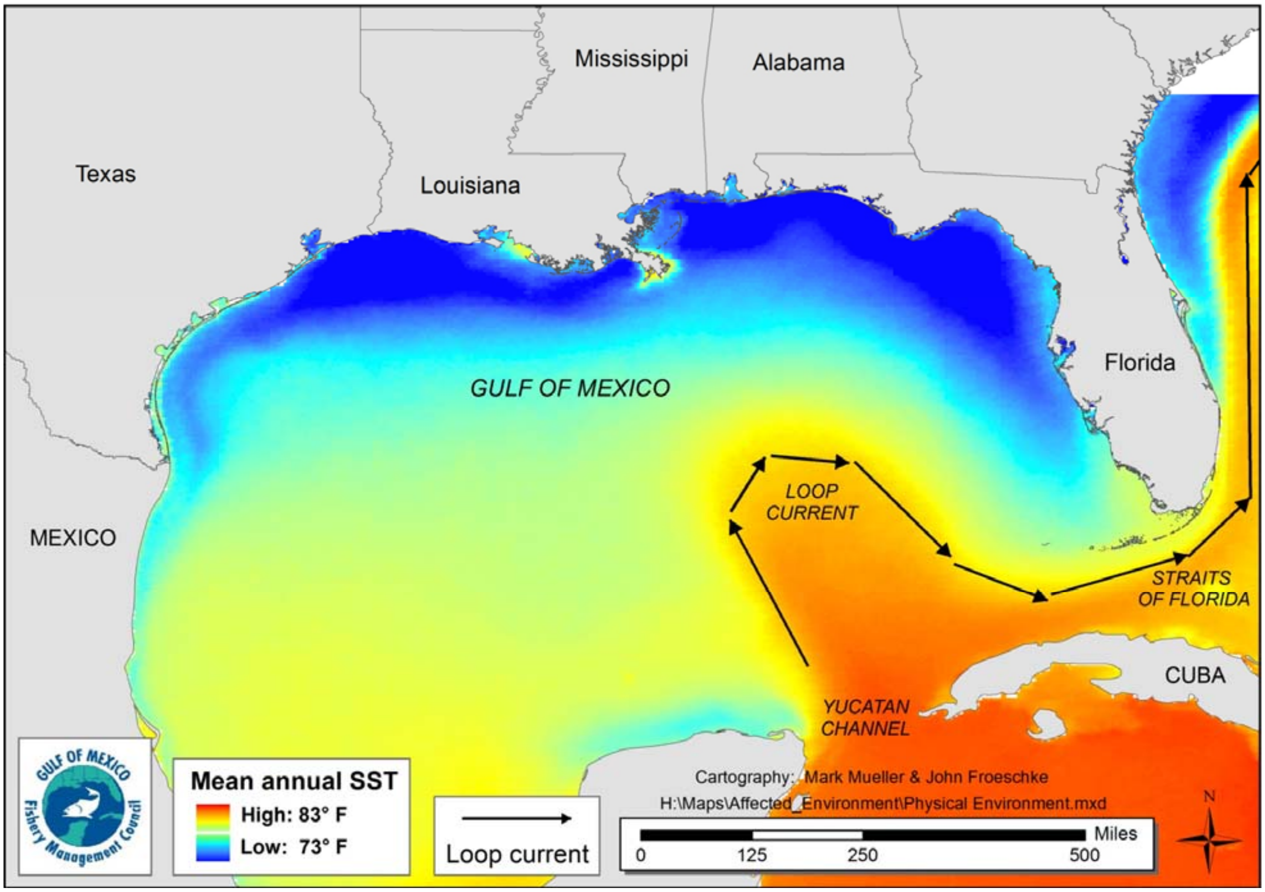

Figure 3.1.1. Physical environment of the Gulf, including major feature names and mean annual sea surface temperature as derived from the Advanced Very High Resolution Radiometer Pathfinder Version 5 sea surface temperature data set (http://accession.nodc.noaa.gov/0072888)

3.2 Description of the Biological Environment

The biological environment of the Gulf, including the species addressed in this amendment, is described in detail in the final EISs for Generic essential fish habitat (EFH) Amendment, the Generic ACL/AM Amendment, and Reef Fish Amendments 28 and 40 (refer to GMFMC 2004a; GMFMC 2011a; GMFMC 2014; GMFMC 2015) and is incorporated here by reference and further summarized below.

General Information on Reef Fish Species

The National Ocean Service collaborated with National Marine Fishery Service (NMFS) and the Gulf of Mexico Fishery Management Council (Council) to develop distributions of reef fish (and other species) in the Gulf (SEA 1998). The National Ocean Service (NOS) obtained fishery-independent data sets for the Gulf, including Southeast Area Monitoring and Assessment Program (SEAMAP), and state trawl surveys. Data from the Estuarine Living Marine Resources Program contain information on the relative abundance of specific species (highly abundant, abundant, common, rare, not found, and no data) for a series of estuaries, by five life stages (adult, spawning, egg, larvae, and juvenile) and month for five seasonal salinity zones (0-0.5, 0.5-5, 5-15, 15-25, and greater than 25 parts per thousand). NOS staff analyzed these data to determine relative abundance of the mapped species by estuary, salinity zone, and month. For some species not in the Estuarine Living Marine Resources Program (ELMRP) database, distribution was classified as only observed or not observed for adult, juvenile, and spawning stages.

Based on the citations above, reef fish are widely distributed in the Gulf, occupying both pelagic and benthic habitats during their life cycle. Habitat types and life history stages are summarized in Appendix B and can be found in more detail in GMFMC (2004a). In general, both eggs and larval stages are planktonic. Larvae feed on zooplankton and phytoplankton. Exceptions to these generalizations include the gray triggerfish that lay their eggs in depressions in the sandy bottom, and gray snapper whose larvae are found around submerged aquatic vegetation. Juvenile and adult reef fish are typically demersal, and are usually associated with bottom topographies on the continental shelf (less than 328 feet; less than 100 m) which have high relief, i.e., coral reefs, artificial reefs, rocky hard-bottom substrates, ledges and caves, sloping soft-bottom areas, and limestone outcroppings. However, several species are found over sand and soft-bottom substrates. Juvenile red snapper are common on mud bottoms in the northern Gulf, particularly from Texas to Alabama. Also, some juvenile snappers (e.g. mutton, gray, red, dog, lane, and yellowtail snappers) and groupers (e.g. goliath grouper, red, gag, and yellowfin groupers) have been documented in inshore seagrass beds, mangrove estuaries, lagoons, and larger bay systems (GMFMC 1981). More detail on hard bottom substrate and coral can be found in the Fishery Management Plan (FMP) for Corals and Coral Reefs (GMFMC and SAFMC 1982).

Many of these species co-occur with other reef fish species and can be incidentally caught when fishermen target other species. In some cases, these fish may be discarded for regulatory reasons and thus are considered bycatch. Bycatch practicability analyses have been completed for red snapper (GMFMC 2004b, GMFMC 2007, GMFMC 2014, GMFMC 2015), grouper (GMFMC 2008a, GMFMC 2009, GMFMC 2011a, GMFMC 2012c), vermilion snapper (GMFMC 2004c), greater amberjack (GMFMC 2008b, GMFMC 2012a), gray triggerfish (GMFMC 2012b), and hogfish (GMFMC 2016). These analyses examined the effects of fishing on these species. In general, these analyses have found that reducing bycatch provides biological benefits to managed species as well as benefits to the fishery through less waste, higher yields, and less forgone yield. However, in some cases, actions are approved that can increase bycatch through regulatory discards such as increased minimum sizes and closed seasons. Under these circumstances, there is some biological benefit to the managed species that outweigh any increases in discards from the action.

Status of Reef Fish Stocks

The Reef Fish FMP currently encompasses 31 species (Table 3.2.1). Eleven other species were removed from the FMP in 2012 through the Generic ACL/AM Amendment (GMFMC 2011a). Stock assessments and stock assessment reviews have been conducted for 13 species and can be found on the Council (www.gulfcouncil.org) and SEDAR (www.sedarweb.org) websites. The 13 assessed species are:

- Red Snapper (SEDAR 7 2005; SEDAR 7 Update 2009; SEDAR 31 2013; SEDAR 31 Update 2015)
- Vermilion Snapper (Porch and Cass-Calay 2001; SEDAR 9 2006c; SEDAR 9 Update 2011a; SEDAR 45 2016)
- Yellowtail Snapper (Muller et al. 2003; SEDAR 3 2003; O'Hop et al. 2012)
- Mutton Snapper (SEDAR 15A 2008; SEDAR 15A Update 2015)
- Gray Triggerfish (Valle et al. 2001; SEDAR 9 2006a; SEDAR 9 Update 2011b; SEDAR 43 2015)
- Greater Amberjack (Turner et al. 2000; SEDAR 9 2006b; SEDAR 9 Update 2010; SEDAR 33 2014a)
- Hogfish (Ault et al. 2003; SEDAR 6 2004b; Cooper et al. 2013; SEDAR 37 2014)
- Red Grouper (NMFS 2002; SEDAR 12 2007; SEDAR 12 Update 2009; SEDAR 42 2015)
- Gag (Turner et al. 2001; SEDAR 10 2006; SEDAR 10 Update 2009; SEDAR 33 2014b)
- Black Grouper (SEDAR 19 2010)
- Yellowedge Grouper (Cass-Calay and Bahnick 2002; SEDAR 22 2011b)
- Tilefish (Golden) (SEDAR 22 2011a)
- Atlantic Goliath Grouper (Porch et al. 2003; SEDAR 6 2004a; SEDAR 23 2011; SEDAR 47 2016).

The NMFS Office of Sustainable Fisheries updates its Status of U.S. Fisheries Report to Congress on a quarterly basis utilizing the most current stock assessment information. The most recent update can be found at: http://www.nmfs.noaa.gov/sfa/fisheries_eco/status_of_fisheries/. The status of both assessed and unassessed stocks as of the writing of this report is shown in Table 3.2.1.

Table 3.2.1. Species of the Reef Fish FMP grouped by family.

Common Name	Scientific Name	Stock Status
Family Balistidae – Triggerfishes		
Gray Triggerfish	*Balistes capriscus*	Overfished, no overfishing
Family Carangidae – Jacks		
Greater Amberjack	*Seriola dumerili*	Overfished, no overfishing
Lesser Amberjack	*Seriola fasciata*	Unknown
Almaco Jack	*Seriola rivoliana*	Unknown
Banded Rudderfish	*Seriola zonata*	Unknown
Family Labridae – Wrasses		
Hogfish	*Lachnolaimus maximus*	Not overfished, no overfishing
Family Malacanthidae – Tilefishes		
Tilefish (Golden)	*Lopholatilus chamaeleonticeps*	Not overfished, no overfishing
Blueline Tilefish	*Caulolatilus microps*	Unknown
Goldface Tilefish	*Caulolatilus chrysops*	Unknown
Family Serranidae – Groupers		
Gag	*Mycteroperca microlepis*	Not overfished, no overfishing
Red Grouper	*Epinephelus morio*	Not overfished, no overfishing
Scamp	*Mycteroperca phenax*	Unknown
Black Grouper	*Mycteroperca bonaci*	Not overfished, no overfishing
Yellowedge Grouper	**Hyporthodus flavolimbatus*	Not overfished, no overfishing
Snowy Grouper	**Hyporthodus niveatus*	Unknown
Speckled Hind	*Epinephelus drummondhayi*	Unknown
Yellowmouth Grouper	*Mycteroperca interstitialis*	Unknown
Yellowfin Grouper	*Mycteroperca venenosa*	Unknown
Warsaw Grouper	**Hyporthodus nigritus*	Unknown
**Atlantic Goliath Grouper	*Epinephelus itajara*	Unknown
Family Lutjanidae – Snappers		
Queen Snapper	*Etelis oculatus*	Unknown
Mutton Snapper	*Lutjanus analis*	Not overfished, no overfishing
Blackfin Snapper	*Lutjanus buccanella*	Unknown
Red Snapper	*Lutjanus campechanus*	Overfished, no overfishing
Cubera Snapper	*Lutjanus cyanopterus*	Unknown, no overfishing
Gray Snapper	*Lutjanus griseus*	Unknown, no overfishing
Lane Snapper	*Lutjanus synagris*	Unknown, no overfishing
Silk Snapper	*Lutjanus vivanus*	Unknown
Yellowtail Snapper	*Ocyurus chrysurus*	Not overfished, no overfishing
Vermilion Snapper	*Rhomboplites aurorubens*	Not overfished, no overfishing
Wenchman	*Pristipomoides aquilonaris*	Unknown

Notes: *In 2013, the genus for yellowedge grouper, snowy grouper, and warsaw grouper was changed by the American Fisheries Society from *Epinephelus* to *Hyporthodus* (American Fisheries Society 2013).
**Atlantic goliath grouper is a protected grouper and benchmarks do not reflect appropriate stock dynamics. In 2013, the common name was changed from goliath grouper to Atlantic goliath grouper by the American Fisheries Society to differentiate from the Pacific goliath grouper, a newly named species (American Fisheries Society 2013).

Protected Species

The Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA) provide special protections to some species that occur in the Gulf. Appendix A includes a very brief summary of how these two laws, and more information is available on NMFS Office of Protected Resources website (http://www.nmfs.noaa.gov/pr/laws/). All 22 marine mammals in the Gulf are protected under the MMPA. Two marine mammals (sperm whales and manatees) are also protected under the ESA. Other species protected under the ESA include five sea turtle species (Kemp's ridley, loggerhead, green, leatherback, and hawksbill), two fish species (Gulf sturgeon and smalltooth sawfish), and five coral species (elkhorn, staghorn, lobed star, mountainous star, and boulder star). Critical habitat designated under the ESA for smalltooth sawfish, Gulf sturgeon, and the Northwest Atlantic Ocean distinct population segment of loggerhead sea turtles also occur in the Gulf, though only loggerhead critical habitat occurs in federal waters.

The following sections provide a brief overview of the marine mammals, sea turtles, and fish that may be present in or near areas where Gulf reef fish fishing occurs and their general life history characteristics. Since none of the listed corals or designated critical habitats in the Gulf are likely to be adversely affected by the Gulf reef fish fishery, they are not discussed further.

Marine Mammals

The 22 species of marine mammals in the Gulf include one sirenian species (a manatee), which is under U.S. Fish and Wildlife Service's (USFWS) jurisdiction, and 21 cetacean species (dolphins and whales), all under NMFS' jurisdiction. Manatees primarily inhabit rivers, bays, canals, estuaries, and coastal waters rich in seagrass and other vegetation off Florida, but can occasionally be found in seagrass habitats as far west as Texas. Although most of the cetacean species reside in the oceanic habitat (greater than or equal to 200 m), the Atlantic spotted dolphin is found in waters over the continental shelf (20-200 m), and the common bottlenose dolphin (hereafter referred to as bottlenose dolphins) is found throughout the Gulf, including within bays, sounds, and estuaries; coastal waters over the continental shelf; and in deeper oceanic waters.

Sperm whales are one of the cetacean species found in offshore waters of the Gulf (greater than 200m) and are listed endangered under the ESA. Sperm whales, are the largest toothed whales and are found year-round in the northern Gulf along the continental slope and in oceanic waters (Waring et al. 2013). There are several areas between Mississippi Canyon and De Soto Canyon where sperm whales congregate at high densities, likely because of localized, highly productive habitats (Biggs et al. 2005; Jochens et al. 2008). There is a resident population of female sperm whales, and whales with calves frequently sighted there.

Bryde's whales are the only resident baleen whales in the Gulf and are currently being evaluated to determine if listing under the ESA is warranted. Bryde's whales (pronounced "BREW-days") in the Gulf are currently restricted to a small area in the northeastern Gulf near De Soto Canyon in waters between 100 – 400 m depth along the continental shelf break, though information in the southern Gulf is sparse (Waring et al. 2013). On September 18, 2014, NMFS received a revised petition from the Natural Resource Defense Council to list the Gulf Bryde's whale as an endangered Distinct Population Segment. On April 6, 2015, NMFS found the petitioned action may be warranted and convened a Status Review Team to prepare a status review report. NMFS will rely on the information status review report to make a 12-month determination as to whether or not listing as endangered or threatened the species is warranted, and if so, a proposed rule will be published in the Federal Register.

Although they are all the same species, **bottlenose dolphins** in the Gulf can be separated into demographically independent populations called stocks. Bottlenose dolphins are currently managed by NMFS as 36 distinct stocks within the Gulf. These include 31 bay, sound and estuary stocks, three coastal stocks, one continental shelf stock, and one oceanic stock (Waring et al. 2013). Additional climatic and oceanographic boundaries delineate the three coastal stocks such that the Gulf Eastern Coastal Stock ranges from 84ºW to Key West, FL, the Gulf Northern Coastal Stock ranges from 84ºW to the Mississippi River Delta, and the Gulf Western Coastal stock ranges from the Mississippi River Delta to the Texas/Mexico border. Marine Mammal Stock Assessment Reports and additional information on these species in the Gulf are available on the NMFS Office of Protected Species website: http://www.nmfs.noaa.gov/pr/.

Bottlenose dolphin adults range from 6 to 9 feet (1.8 to 2.8 m) long and weigh typically between 300 to 600 pounds (136 to 272 kg). Females and males reach sexual maturity between ages 5 to 13 and 9 to 14, respectively. Once mature, females give birth once every 3 to 6 years. Maximum known lifespan can be 50 years for males and greater than 60 years for females (Reynolds 2000).

The MMPA requires that each commercial fishery be classified by the number of marine mammals they seriously injure or kill. NMFS's List of Fisheries classifies U.S. commercial fisheries into three categories based on the number of incidental mortality or serious injury they cause to marine mammals. More information about the List of Fisheries and the classification process can be found at: http://www.nmfs.noaa.gov/pr/interactions/fisheries/lof.html.

NMFS classifies reef fish bottom longline/hook-and-line gear in the MMPA 2016 List of Fisheries as a Category III fishery (81 FR 20550). This classification indicates the annual mortality and serious injury of a marine mammal stock resulting from any fishery is less than or equal to 1% of the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population. Dolphins are the only species documented as interacting with these fisheries. Bottlenose dolphins are a common predator around reef fish vessels. They prey upon on the bait, catch, and/or released discards of fish from the reef fish fishery.

Turtles

Green, hawksbill, Kemp's ridley, leatherback, and loggerhead sea turtles are all highly migratory and travel widely throughout the Gulf. Several volumes exist that cover the biology and ecology of these species (i.e., Lutz and Musick (eds.) 1997; Lutz et al. (eds.) 2003, Wynekan et al. (eds.) 2013).

Green sea turtle hatchlings are thought to occupy pelagic areas of the open ocean and are often associated with *Sargassum* rafts (Carr 1987; Walker 1994). Pelagic stage green sea turtles are thought to be carnivorous. Stomach samples of these animals found ctenophores and pelagic snails (Frick 1976; Hughes 1974). At approximately 20 to 25 cm carapace length, juveniles migrate from pelagic habitats to benthic foraging areas (Bjorndal 1997). As juveniles move into benthic foraging areas a diet shift towards herbivory occurs. They consume primarily seagrasses and algae, but are also known to consume jellyfish, salps, and sponges (Bjorndal 1980, 1997; Paredes 1969; Mortimer 1981, 1982). The diving abilities of all sea turtles species vary by their life stages. The maximum diving range of green sea turtles is estimated at 110 m (360 ft) (Frick 1976), but they are most frequently making dives of less than 20 m (65 ft.) (Walker 1994). The time of these dives also varies by life stage. The maximum dive length is estimated at 66 minutes with most dives lasting from 9 to 23 minutes (Walker 1994).

The **hawksbill's** pelagic stage lasts from the time they leave the nesting beach as hatchlings until they are approximately 22-25 cm in straight carapace length (Meylan 1988; Meylan and Donnelly 1999). The pelagic stage is followed by residency in developmental habitats (foraging areas where juveniles reside and grow) in coastal waters. Little is known about the diet of pelagic stage hawksbills. Adult foraging typically occurs over coral reefs, although other hard-bottom communities and mangrove-fringed areas are occupied occasionally. Hawksbills show fidelity to their foraging areas over several years (van Dam and Diéz 1998). The hawksbill's diet is highly specialized and consists primarily of sponges (Meylan 1988). Gravid females have been noted ingesting coralline substrate (Meylan 1984) and calcareous algae (Anderes Alvarez and Uchida 1994), which are believed to be possible sources of calcium to aid in eggshell production. The maximum diving depths of these animals are not known, but the maximum length of dives is estimated at 73.5 minutes. More routinely, dives last about 56 minutes (Hughes 1974).

Kemp's ridley hatchlings are also pelagic during the early stages of life and feed in surface waters (Carr 1987; Ogren 1989). After the juveniles reach approximately 20 cm carapace length they move to relatively shallow (less than 50m) benthic foraging habitat over unconsolidated substrates (Márquez-M. 1994). They have also been observed transiting long distances between foraging habitats (Ogren 1989). Kemp's ridleys feeding in these nearshore areas primarily prey on crabs, though they are also known to ingest mollusks, fish, marine vegetation, and shrimp (Shaver 1991). The fish and shrimp Kemp's ridleys ingest are not thought to be a primary prey item but instead may be scavenged opportunistically from bycatch discards or discarded bait (Shaver 1991). Given their predilection for shallower water, Kemp's ridleys most routinely make dives of 50 m or less (Soma 1985; Byles 1988). Their maximum diving range is unknown. Depending on the life stage a Kemp's ridleys may be able to stay submerged anywhere from 167 minutes to 300 minutes, though dives of 12.7 minutes to 16.7 minutes are much more common (Soma 1985; Mendonca and Pritchard 1986; Byles 1988). Kemp's ridleys may also spend as much as 96% of their time underwater (Soma 1985; Byles 1988).

Leatherbacks are the most pelagic of all ESA-listed sea turtles and spend most of their time in the open ocean. Although they will enter coastal waters and are seen over the continental shelf on a seasonal basis to feed in areas where jellyfish are concentrated. Leatherbacks feed primarily on cnidarians (medusae, siphonophores) and tunicates. Unlike other sea turtles, leatherbacks' diets do not shift during their life cycles. Because leatherbacks' ability to capture and eat jellyfish is not constrained by size or age, they continue to feed on these species regardless of life stage (Bjorndal 1997). Leatherbacks are the deepest diving of all sea turtles. It is estimated that these species can dive in excess of 1000 m (Eckert et al. 1989) but more frequently dive to depths of 50 m to 84 m (Eckert et al. 1986). Dive times range from a maximum of 37 minutes to more routines dives of 4 to 14.5 minutes (Standora et al. 1984; Eckert et al. 1986; Eckert et al. 1989; Keinath and Musick 1993). Leatherbacks may spend 74% to 91% of their time submerged (Standora et al. 1984).

Loggerhead hatchlings forage in the open ocean and are often associated with *Sargassum* rafts (Hughes 1974; Carr 1987; Walker 1994; Bolten and Balazs 1995). The pelagic stage of these sea turtles are known to eat a wide range of things including salps, jellyfish, amphipods, crabs, syngnathid fish, squid, and pelagic snails (Brongersma 1972). Stranding records indicate that when pelagic immature loggerheads reach 40-60 cm straight-line carapace length, they begin to live in coastal inshore and nearshore waters of the continental shelf throughout the U.S. Atlantic (Witzell 2002). Here they forage over hard- and soft-bottom habitats (Carr 1986). Benthic foraging loggerheads eat a variety of invertebrates with crabs and mollusks being an important prey source (Burke et al. 1993). Estimates of the maximum diving depths of loggerheads range from 211 m to 233 m (692-764ft.) (Thayer et al. 1984; Limpus and Nichols 1988). The lengths of loggerhead dives are frequently between 17 and 30 minutes (Thayer et al. 1984; Limpus and Nichols 1988; Limpus and Nichols 1994; Lanyon et al. 1989) and they may spend anywhere from 80 to 94% of their time submerged (Limpus and Nichols 1994; Lanyon et al. 1989).

All of the above sea turtles are adversely affected by the Gulf reef fish fishery. Incidental captures are- infrequent, but occur in all commercial and recreational hook-and-line and longline components of the reef fish fishery. Observer data indicate that the bottom longline component of the fishery interacts solely with loggerhead sea turtles. Captured loggerhead sea turtles can be released alive or can be found dead upon retrieval of bottom longline gear as a result of forced submergence. Sea turtles caught during other reef fish fishing with other gears are believed to all be released alive due to shorter gear soak. All sea turtles released alive may later succumb to injuries sustained at the time of capture or from exacerbated trauma from fishing hooks or lines that were ingested, entangled, or otherwise still attached when they were released. Sea turtle release gear and handling protocols are required in the commercial and for-hire reef fish fisheries to minimize post-release mortality.

NMFS has conducted specific analyses ("Section 7 consultations") evaluating potential effects from the Gulf reef fish fishery on sea turtles (as well as on other ESA-listed species and critical habitat) as required by the ESA. On September 30, 2011, Southeast Regional Office (SERO) completed a biological opinion (Opinion), which concluded that the continued authorization of the Gulf reef fish fishery is not likely to jeopardize the continued existence of any sea turtles (loggerhead, Kemp's ridley, green, hawksbill, and leatherback) (NMFS 2011). An incidental take statement was issued specifying the amount and extent of anticipated take, along with reasonable and prudent measures and associated terms and conditions deemed necessary and appropriate to minimize the impact of these takes. On September 29, 2016, NMFS reinitiated consultation on the continued authorization of the Gulf reef fish fishery because new species

(Nassau grouper and green sea turtle North Atlantic and South Atlantic DPSs) have been listed under the ESA that may be affected by the fishery.

Fish

Historically the **smalltooth sawfish** in the U.S. ranged from New York to the Mexico border. Their current range is poorly understood but believed to have contracted from these historical areas. Smalltooth sawfish primarily occur in the Gulf off peninsular Florida and are most common off Southwest Florida and the Florida Keys. Historical accounts and recent encounter data suggest that immature individuals are most common in shallow coastal waters less than 25 meters (Bigelow and Schroeder 1953; Adams and Wilson 1995), while mature animals occur in waters in excess of 100 meters (Simpfendorfer and Wiley 2005). Smalltooth sawfish feed primarily on fish. Mullet, jacks, and ladyfish are believed to be their primary food resources (Simpfendorfer 2001). Smalltooth sawfish also prey on crustaceans (mostly shrimp and crabs) by disturbing bottom sediment with their saw (Norman and Fraser 1938; Bigelow and Schroeder 1953).

Smalltooth sawfish are also adversely affected by the Gulf reef fish fishery, but are interacted with to a much lesser extent than sea turtles. Although the long, toothed rostrum of the smalltooth sawfish causes this species to be particularly vulnerable to entanglement in fishing gear, incidental captures in the commercial and recreational hook-and-line components of the reef fish fishery are rare events. Only eight smalltooth sawfish are anticipated to be incidentally caught every three year in the entire ref fish fishery, and none are expected to result in mortality (NMFS 2011). In the September 30, 2011, Opinion, NMFS concluded that the continued authorization of the Gulf reef fish fishery is not likely to jeopardize the continued existence of smalltooth sawfish (NMFS 2011). An incidental take statement was issued specifying the amount and extent of anticipated take, along with reasonable and prudent measures and associated terms and conditions deemed necessary and appropriate to minimize the impact of these takes. Fishermen in this fishery are required to follow smalltooth sawfish safe handling guidelines.

The **Nassau grouper** is a shallow-water grouper species that has supported fisheries throughout the wider Caribbean, South Florida, Bermuda, and the Bahamas (Carter et al. 1994). Like other grouper species, they are slow-growing and long-lived (at least to age 29 years; Bush et al. 1996). Eggs and larvae are pelagic, but transition as juveniles to macroalgal and seagrass habitats. Adults are primarily found on high relief coral reefs and rocky substrates (Sadovy and Eklund 1999). Adults undergo annual migrations to discrete locations where they aggregate in large numbers to spawn (Smith 1972, Olsen and LaPlace 1979, Colin et al. 1987, Fine 1990, Fine 1992, Colin 1992). After spawning, the return to their home reef (Sadovy and Eklund 1999).

Nassau grouper are caught with spear, traps, and hook-and-line (NMFS 2016). Because many of the spawning aggregations were well known, fishermen have fished these aggregations out to the point that in U.S. waters, there are no known spawning aggregations. To protect Nassau grouper from this overharvest, the Caribbean, South Atlantic, and Gulf of Mexico Fishery Management Councils, as well as the state of Florida have prohibited take and possession of Nassau grouper.

On June 29, 2016, NMFS published a final rule (81 FR 42268) listing Nassau grouper as threatened under the ESA.

Northern Gulf of Mexico Hypoxic Zone

Every summer in the northern Gulf, a large hypoxic zone forms. It is the result of allochthonous materials and runoff from agricultural lands by rivers to the Gulf, increasing nutrient inputs from the Mississippi River, and a seasonal layering of waters in the Gulf (see http://www.gulfhypoxia.net/). The layering of the water is temperature and salinity dependent and prevents the mixing of higher oxygen content surface water with oxygen-poor bottom water. For 2014, the extent of the hypoxic area was estimated to be 5,052 square miles and is similar the running average for over the past five years of 5,543 square miles Gulf (see http://www.gulfhypoxia.net/).

The hypoxic conditions in the northern Gulf directly impact less mobile benthic macroinvertebrates (e.g., polychaetes;) by influencing density, species richness, and community composition (Baustian and Rabalais 2009). However, more mobile macroinvertebrates and demersal fishes (e.g., red snapper) are able to detect lower dissolved oxygen levels and move away from hypoxic conditions. Therefore, although not directly affected, these organisms are indirectly affected by limited prey availability and constrained available habitat (Baustian and Rabalais 2009; Craig 2012). For red snapper, Courtney et al. (2013) have conjectured that the hypoxic zone could have an indirect positive effect on red snapper populations in the western Gulf. They theorize that increased nutrient loading may be working in ‘synergy’ with abundant red snapper artificial habitats (oil platforms). Nutrient loading likely increases forage species biomass and productivity providing ample prey for red snapper residing on the oil rigs, thus increasing red snapper productivity.

Climate change

Climate change projections show increases in sea surface temperature and sea level; decreases in sea ice cover; and changes in salinity, wave climate, and ocean circulation [Intergovernmental Panel on Climate Change (IPCC) http://www.ipcc.ch/]. These changes are likely to affect plankton biomass and fish larvae abundance that could adversely impact fish, marine mammals, seabirds, and ocean biodiversity. Kennedy et al. (2002) and Osgood (2008) have suggested global climate change could bring about temperature changes in coastal and marine ecosystems that, in turn, can influence organism metabolism; alter ecological processes, such as productivity and species interactions; change precipitation patterns and cause a rise in sea level that could change the water balance of coastal ecosystems; alter patterns of wind and water circulation in the ocean environment; and influence the productivity of critical coastal ecosystems such as wetlands, estuaries, and coral reefs. National Oceanic and Atmospheric Administration’s (NOAA) Climate Change Web Portal (http://www.esrl.noaa.gov/psd/ipcc/ocn/) indicates that the average sea surface temperature in the Gulf will increase by 1.2-1.4ºC for 2006-2055 compared to the average over the years 1956-2005. For reef fishes, Burton (2008) speculated that climate change could cause shifts in spawning seasons, changes in migration patterns, and changes to basic life history parameters such as growth rates. The OceanAdapt model (http://oceanadapt.rutgers.edu/regional_data/) shows distributional trends both in latitude and depth over the time period 1985-1013. For some reef fish species such as the smooth puffer, there has been a distributional trend to the north in the Gulf. For other species such as red snapper and the dwarf sand perch, there has been a distributional trend towards deeper waters. Finally, for other reef fish species such as the dwarf goatfish, there has been a distributional trend both to the north and to deeper waters. These changes in distributions have been hypothesized as a response to environmental factors such as increases in temperature.

The distribution of native and exotic species may change with increased water temperature, as may the prevalence of disease in keystone animals such as corals and the occurrence and intensity of toxic algae blooms. Hollowed et al. (2013) provided a review of projected effects of climate change on the marine fisheries and dependent communities. Integrating the potential effects of climate change into the fisheries assessment is currently difficult due to the time scale differences (Hollowed et al. 2013). The fisheries stock assessments rarely project through a time span that would include detectable climate change effects.

Greenhouse gases
The IPCC (http://www.ipcc.ch/) has indicated that greenhouse gas emissions are one of the most important drivers of recent changes in climate. Wilson et al. (2014) inventoried the sources of greenhouse gases in the Gulf from sources associated with oil platforms and those associated with other activities such as fishing. A summary of the results of the inventory are shown in Table 3.2.2 with respect to total emissions and from fishing. Commercial fishing and recreational vessels make up a small percentage of the total estimated greenhouse gas emissions from the Gulf (1.43% and 0.59%, respectively).

Table 3.2.2. Total Gulf of Mexico greenhouse gas emissions estimates (tons per year) from oil platform and non-oil platform sources, commercial fishing and recreational vessels, and percent greenhouse gas emissions from commercial fishing and recreational vessels of the total emissions*.

Emission source	Greenhouse Gas			
	CO_2	**CH_4**	**N_2O**	**Total CO_{2e}****
Oil platform	11,882,029	271,355	167	17,632,106
Non-platform	22,703,695	2,029	2,698	23,582,684
Total	34,585,724	273,384	2,865	41,214,790
Commercial fishing	585,204	2	17	590,516
Recreational vessels	244,483	N/A	N/A	244,483
Percent commercial fishing	1.69	>0.01	0.59	1.43
Percent recreational vessels	0.71	NA	NA	0.59

*Compiled from Tables 7.9 and 7.10 in Wilson et al. (2014).

**The CO_2 equivalent (CO_2e) emission estimates represent the number of tons of CO_2 emissions with the same global warming potential as one ton of another greenhouse gas (e.g., CH_4 and N_2O). Conversion factors to CO_{2e} are 21 for CH_4 and 310 for N_2O.

Deepwater Horizon MC252 Oil Spill Incident

On April 20, 2010, an explosion occurred on the *Deepwater Horizon* semi-submersible oil rig approximately 36 nautical miles (41 statute miles) off the Louisiana coast. Two days later the rig sank. An uncontrolled oil leak from the damaged well continued for 87 days until the well was successfully capped by British Petroleum on July 15, 2010. The *Deepwater Horizon* MC252 oil spill affected at least one-third of the Gulf area from western Louisiana east to the Florida Panhandle and south to the Campeche Bank in Mexico. In response to the spill, NMFS closed waters in the Gulf to fishing, and at its height, closed over 88,000 square miles (Figure 3.2.1)

A final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement (PDARP), and incorporated by reference, were conducted by NOAA and many cooperating agencies to assess the damage caused by the spill (DWH Trustees 2016). Key findings by NOAA with regards to the injury assessment were:

- Oil came into contact with a variety of northern Gulf habitats ranging from the deep-sea floor to coastal and nearshore areas.
- Species affected included deep-sea corals, fish and shellfish, birds, among others.
- The oil was toxic to a wide variety of organisms including fish, invertebrates, plankton, birds, deep-sea corals, sea turtles, and marine mammals.
- Toxic effects included death, disease, reduced growth, impaired reproduction, and physiological impairments that made it more difficult for organisms to survive and reproduce.
- The extent and degree of toxic levels of oil has declined substantially from 2010 to the present.

The PDARP outlines ways fish, including reef fish, were likely adversely affected. Affects include reduced recruitment, changes in trophic structure, changes in community structure, reduced growth, impaired reproduction, and adverse health effects. A more detailed description of these effects can be found in Chapter 4 of the PDARP (http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan).

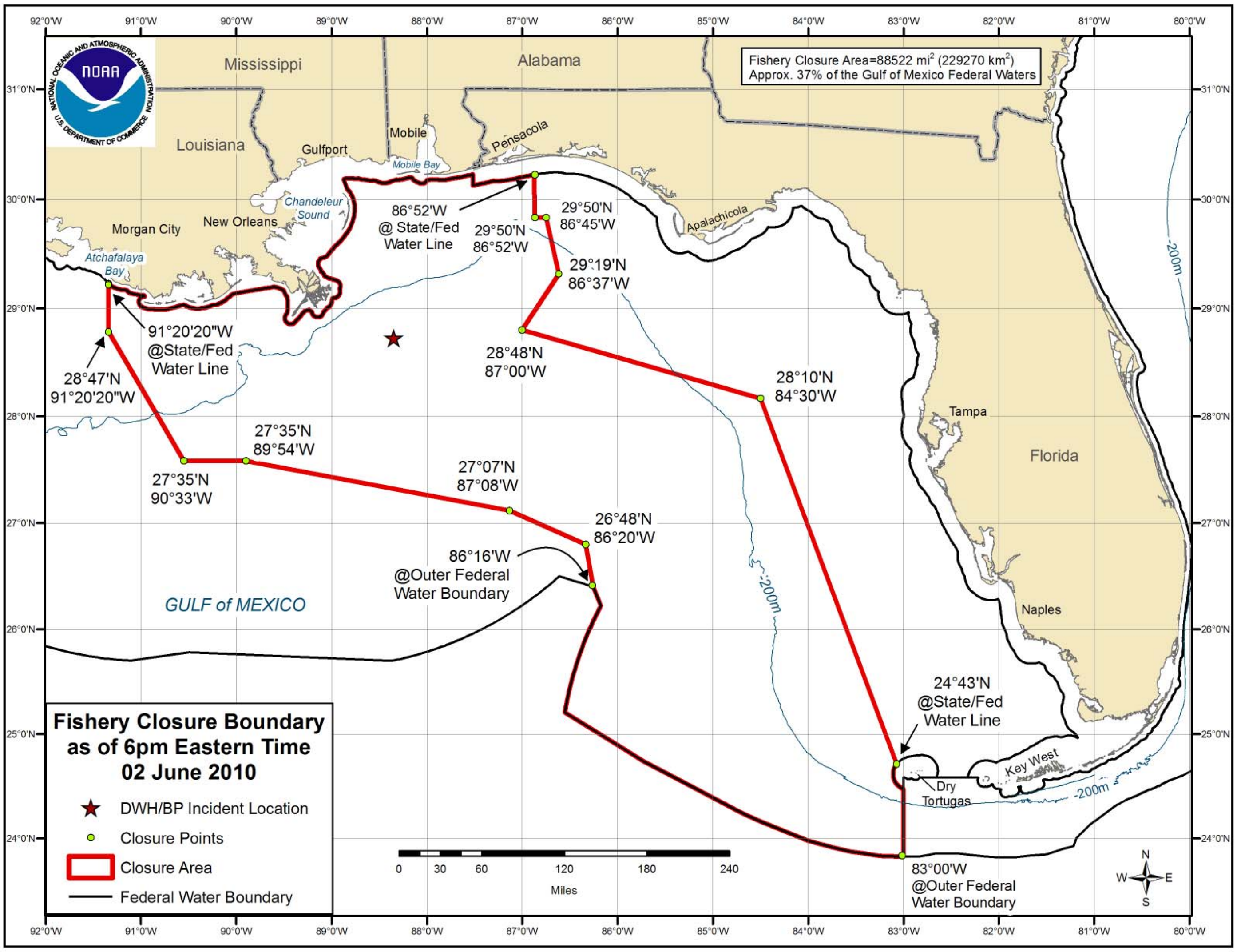

Figure 3.2.1. Fishery closure at the height of the Deepwater Horizon MC252 oil spill.

3.3 Description of the Economic Environment

3.3.1 Commercial Sector

The following sections contain information on select aspects of the commercial sector of the reef fish fishery in the Gulf, generally for the period 2011-2015. Final data for 2016 are not available at this time and preliminary data is not included in this description. Additional data, encompassing either different years or different aspects of the fishery, for all the species in the reef fish fishery management unit (FMU) can be found in GMFMC (2011), and in the following references for the species listed: GMFMC (2015b), GMFMC (2015c), and NMFS (2015b) for red snapper; NMFS (2015a) for the grouper and tilefish species; GMFMC (2012c) for gray triggerfish; GMFMC (2015a) for greater amberjack; and GMFMC (2016b) for yellowtail snapper. Detailed information for hogfish is found in GMFMC (2016a).

Vessel Activity

Tables 3.3.1.1-3.3.1.12 contain information on vessel performance for commercial vessels that harvested reef fish in the Gulf in 2011-2014. The data are provided for all reef fish species in the FMU combined (Tables 3.3.1.1 and 3.3.1.2), all species combined in the grouper-tilefish limited access privilege program LAPP (Table 3.3.1.3 and 3.3.1.4), and for the individual species red snapper (Table 3.3.1.5 and 3.3.1.6), gray triggerfish (Table 3.3.1.7 and 3.3.1.8), greater amberjack (Table 3.3.1.9 and 3.3.1.10), and vermilion snapper (Table 3.3.1.1 and 3.3.1.12). The tables contain vessel counts from the NMFS Southeast Fisheries Science Center (SEFSC) logbook (logbook) data (vessel count, trips, and landings). Dockside values were generated using landings information from logbook data and price information from the NMFS SEFSC Accumulated Landings System (ALS) data. These data only contain information on the harvest of finfish by these vessels and not the harvest from any non-finfish fisheries that these vessels may participate in. These data should not be added across tables because this would result in double counting. Finally, the species group data (all reef fish species in the FMU and species in the grouper-tilefish limited access privilege program - LAPP) only include harvest data that listed the specific individual species included in the group and not data recorded for similar but unidentified species (e.g., "snappers" and "groupers"). As a result, the totals for the grouped-species categories (e.g., reef fish landings, dockside revenue from reef fish) may not include all of the actual landings and associated revenue for the species encompassed by each group. However, data in the general "unidentified species" groups would be included in the "Other Species Landings Jointly Caught with…" and "Landings on Other Trips" data. As a result, the estimates of total landings, total revenue, and average revenue per vessel include the harvest of all species included in the logbook data for the respective vessels.

On average, 550 commercial vessels per year landed reef fish FMU species over the period 2011-2015 (Table 3.3.1.1). These vessels, combined, averaged 6,609 trips per year in the Gulf on which reef fish species were landed and 837 trips in the Gulf without reef fish or in the South Atlantic (Table 3.3.1.1). The average annual total dockside revenue (2015 dollars) was approximately $53.10 million from species in the reef fish FMU, approximately $1.38 million from other species co-harvested with species in the reef fish FMU (on the same trip), and approximately $3.02 million from other trips by these vessels (Table 3.3.1.2). The total average annual revenue from all finfish species harvested by vessels harvesting species in the reef fish FMU was approximately $57.51 million, or approximately $104,600 per vessel (Table 3.3.1.2).

Among the annual average of 550 vessels that harvested species in the reef fish FMU, an average of 454 vessels per year harvested species in the grouper-tilefish LAPP (Table 3.3.1.3) and 379 harvested red snapper (Table 3.3.1.5). For the three other individual reef fish species examined, gray triggerfish, greater amberjack, and vermilion snapper, more vessels harvested vermilion snapper, an average of 339 vessels per year (Table 3.3.1.11) than harvested the other two species. In terms of species dependence, reef fish accounted for approximately 92% of the total annual revenues for vessels that harvested reef fish, grouper-tilefish accounted for approximately 48% of the total annual revenues for vessels that harvested grouper-tilefish, and red snapper accounted for approximately 36% of the total annual revenues for vessels that harvested red snapper (using data contained in Tables 3.3.1.2, 3.3.1.4, and 3.3.1.6; percentages not provided in the tables). Among the remaining three species examined, gray triggerfish accounted for less than 1% of average annual revenues, greater amberjack approximately 2%, and vermilion snapper approximately 12% (see Tables 3.3.1.8, 3.3.1.10, and 3.3.1.12). The average annual revenue per vessel across all the categories examined ranged from approximate $104,600 (vessels that harvested any species in the reef fish FMU; Table 3.3.1.2) to approximately $172,700 (vessels that harvested greater amberjack; Table 3.3.1.10).

Table 3.3.1.1. Summary of vessel counts, trips, and logbook landings (pounds gutted weight (lbs gw)) or vessels landing at least one pound of reef fish, 2011-2015.

Year	Number of Vessels	Number of Gulf Trips on which Reef Fish were Caught	Reef Fish Landings (lbs gw)	"Other Species" Landings Jointly Caught with Reef Fish (lbs gw)	Number of Other Trips*	Landings on Other Trips (lbs gw)
2011	561	6,539	13,343,057	943,660	767	1,232,556
2012	554	6,593	13,983,672	968,937	904	1,076,039
2013	531	6,287	13,626,126	768,528	799	1,218,552
2014	574	6,968	15,438,913	894,190	1,011	1,249,266
2015	532	6,659	14,548,652	711,849	706	1,344,144
Average	550	6,609	14,188,084	857,433	837	1,224,111

Source: NMFS SEFSC Logbook data.
*Includes Gulf trips on which reef fish were not harvested and trips in the South Atlantic on which reef fish may have been harvested.

Table 3.3.1.2. Summary of vessel counts and revenue (2015 dollars) for vessels landing at least one pound of reef fish, 2011-2015.

Year	Number of Vessels	Dockside Revenue from Reef Fish	Dockside Revenue from “Other Species” Jointly Caught with Reef Fish	Dockside Revenue on Other Trips*	Total Dockside Revenue	Average Total Dockside Revenue per Vessel
2011	561	$44,642,853	$1,389,489	$2,592,443	$48,624,785	$86,675
2012	554	$49,015,496	$1,433,196	$2,326,133	$52,774,825	$95,261
2013	531	$52,152,945	$1,325,915	$2,736,478	$56,215,338	$105,867
2014	574	$60,211,874	$1,463,159	$3,189,719	$64,864,752	$113,005
2015	532	$59,486,917	$1,292,634	$4,271,794	$65,051,345	$122,277
Average	550	$53,102,017	$1,380,879	$3,023,313	$57,506,209	$104,617

Source: NMFS SEFSC Logbook and ALS data.
*Includes Gulf trips on which reef fish were not harvested and trips in the South Atlantic on which reef fish may have been harvested.

Table 3.3.1.3. Summary of vessel counts, trips, and logbook landings (pounds gutted weight (lbs gw)) or vessels landing at least one pound of grouper-tilefish*, 2011-2015.

Year	Number of Vessels	Number of Gulf Trips on which Grouper-Tilefish were Caught	Grouper-Tilefish Landings (lbs gw)	“Other Species” Landings Jointly Caught with Grouper-Tilefish (lbs gw)	Number of Other Trips**	Landings on Other Trips (lbs gw)
2011	460	4,615	6,217,219	5,852,088	1,591	1,838,735
2012	461	4,819	7,070,983	5,759,548	1,666	1,962,591
2013	436	4,591	6,582,818	5,562,110	1,558	2,184,921
2014	465	5,061	7,671,466	5,916,728	1,742	2,714,768
2015	448	4,776	6,295,217	5,491,362	1,715	3,482,676
Average	454	4,772	6,767,541	5,716,367	1,654	2,436,738

Source: NMFS SEFSC Logbook data.
*Includes all grouper-tilefish LAPP species.
**Includes Gulf trips on which grouper-tilefish were not harvested and trips in the South Atlantic on which grouper-tilefish may have been harvested.

Table 3.3.1.4. Summary of vessel counts and revenue (2015 dollars) for vessels landing at least one pound of grouper-tilefish*, 2011-2015.

Year	Number of Vessels	Dockside Revenue from Grouper-Tilefish	Dockside Revenue from "Other Species" Jointly Caught with Grouper-Tilefish	Dockside Revenue on Other Trips**	Total Dockside Revenue	Average Total Dockside Revenue per Vessel
2011	460	$21,626,619	$18,008,594	$4,953,110	$44,588,323	$96,931
2012	461	$25,300,611	$18,382,462	$5,674,547	$49,357,620	$107,066
2013	436	$25,316,006	$20,228,736	$7,333,188	$52,877,930	$121,280
2014	465	$30,141,339	$21,303,345	$9,621,010	$61,065,694	$131,324
2015	448	$25,988,032	$21,023,786	$13,336,972	$60,348,790	$134,707
Average	454	$25,674,521	$19,789,385	$8,183,765	$53,647,671	$118,262

Source: NMFS SEFSC Logbook and ALS data.
*Includes all grouper-tilefish LAPP species.
**Includes Gulf trips on which grouper-tilefish were not harvested and trips in the South Atlantic on which grouper-tilefish may have been harvested.

Table 3.3.1.5. Summary of vessel counts, trips, and logbook landings (pounds gutted weight (lbs gw)) or vessels landing at least one pound of red snapper, 2011-2015.

Year	Number of Vessels	Number of Gulf Trips on which Red Snapper were Caught	Red Snapper Landings (lbs gw)	"Other Species" Landings Jointly Caught with Red Snapper (lbs gw)	Number of Other Trips*	Landings on Other Trips (lbs gw)
2011	367	3,389	3,073,697	5,467,639	1,959	4,218,770
2012	365	3,432	3,468,643	5,455,162	2,026	4,497,194
2013	367	3,458	4,465,607	5,217,212	1,758	3,640,390
2014	402	3,790	4,718,914	5,902,610	2,069	4,677,931
2015	394	4,008	5,822,585	5,576,619	1,981	3,518,806
Average	379	3,615	4,309,889	5,523,848	1,959	4,110,618

Source: NMFS SEFSC Logbook data.
*Includes Gulf trips on which red snapper were not harvested and trips in the South Atlantic on which red snapper may have been harvested.

Table 3.3.1.6. Summary of vessel counts and revenue (2015 dollars) for vessels landing at least one pound of red snapper, 2011-2015.

Year	Number of Vessels	Dockside Revenue from Red Snapper	Dockside Revenue from "Other Species" Jointly Caught with Red Snapper	Dockside Revenue on Other Trips*	Total Dockside Revenue	Average Total Dockside Revenue per Vessel
2011	367	$11,644,205	$16,684,752	$12,507,253	$40,836,210	$111,270
2012	365	$13,765,959	$17,172,431	$14,016,956	$44,955,346	$123,165
2013	367	$19,605,337	$17,653,398	$12,690,604	$49,949,339	$136,102
2014	402	$21,387,438	$20,186,720	$16,549,584	$58,123,742	$144,586
2015	394	$26,619,720	$20,328,120	$12,484,724	$59,432,564	$150,844
Average	379	$18,604,532	$18,405,084	$13,649,824	$50,659,440	$133,194

Source: NMFS SEFSC Logbook and ALS data.

*Includes Gulf trips on which red snapper were not harvested and trips in the South Atlantic on which red snapper may have been harvested.

Table 3.3.1.7. Summary of vessel counts, trips, and logbook landings (pounds gutted weight (lbs gw)) or vessels landing at least one pound of gray triggerfish, 2011-2015.

Year	Number of Vessels	Number of Gulf Trips on which Gray Triggerfish were Caught	Gray Triggerfish Landings (lbs gw)	"Other Species" Landings Jointly Caught with Gray Triggerfish (lbs gw)	Number of Other Trips*	Landings on Other Trips (lbs gw)
2011	284	1,748	87,042	4,905,758	2,698	5,888,725
2012	244	1,066	64,004	3,050,682	2,891	7,186,203
2013	212	1,234	54,130	3,731,574	2,004	4,765,751
2014	228	1,176	33,931	3,298,968	2,614	5,785,481
2015	218	1,238	39,041	3,457,059	2,401	5,804,785
Average	237	1,292	55,630	3,688,808	2,522	5,886,189

Source: NMFS SEFSC Logbook data.

*Includes Gulf trips on which gray triggerfish were not harvested and trips in the South Atlantic on which gray triggerfish may have been harvested.

Table 3.3.1.8. Summary of vessel counts and revenue (2015 dollars) for vessels landing at least one pound of gray triggerfish, 2011-2015.

Year	Number of Vessels	Dockside Revenue from Gray Triggerfish	Dockside Revenue from "Other Species" Jointly Caught with Gray Triggerfish	Dockside Revenue on Other Trips*	Total Dockside Revenue	Average Total Dockside Revenue per Vessel
2011	284	$133,359	$15,556,212	$18,587,463	$34,277,034	$120,694
2012	244	$107,020	$10,104,073	$23,871,856	$34,082,949	$139,684
2013	212	$109,156	$14,073,615	$18,051,722	$32,234,493	$152,049
2014	228	$64,167	$12,113,206	$21,210,106	$33,387,479	$146,436
2015	218	$82,748	$13,654,692	$23,555,192	$37,292,632	$171,067
Average	237	$99,290	$13,100,360	$21,055,268	$34,254,917	$145,986

Source: NMFS SEFSC Logbook and ALS data.
*Includes Gulf trips on which gray triggerfish were not harvested and trips in the South Atlantic on which gray triggerfish may have been harvested.

Table 3.3.1.9. Summary of vessel counts, trips, and logbook landings (pounds gutted weight (lbs gw)) or vessels landing at least one pound of greater amberjack, 2011-2015.

Year	Number of Vessels	Number of Gulf Trips on which Greater Amberjack were Caught	Greater Amberjack Landings (lbs gw)	"Other Species" Landings Jointly Caught with Greater Amberjack (lbs gw)	Number of Other Trips*	Landings on Other Trips (lbs gw)
2011	191	524	445,027	1,155,942	3,029	6,778,028
2012	142	314	270,223	692,299	2,458	5,801,835
2013	185	503	359,556	1,181,923	2,720	7,351,816
2014	221	719	427,218	1,806,542	3,472	9,100,843
2015	180	540	389,391	1,337,251	2,850	8,323,494
Average	184	520	378,283	1,234,791	2,906	7,471,203

Source: NMFS SEFSC Logbook data.
*Includes Gulf trips on which greater amberjack were not harvested and trips in the South Atlantic on which greater amberjack may have been harvested.

Table 3.3.1.10. Summary of vessel counts and revenue (2015 dollars) for vessels landing at least one pound of greater amberjack, 2011-2015.

Year	Number of Vessels	Dockside Revenue from Greater Amberjack	Dockside Revenue from "Other Species" Jointly Caught with Greater Amberjack	Dockside Revenue on Other Trips*	Total Dockside Revenue	Average Total Dockside Revenue per Vessel
2011	191	$574,682	$3,691,241	$21,652,038	$25,917,961	$135,696
2012	142	$349,665	$2,201,064	$18,855,555	$21,406,284	$150,748
2013	185	$539,336	$4,363,562	$27,244,843	$32,147,741	$173,772
2014	221	$647,012	$6,709,831	$34,076,752	$41,433,595	$187,482
2015	180	$590,513	$5,164,497	$33,123,742	$38,878,752	$215,993
Average	184	$540,242	$4,426,039	$26,990,586	$31,956,867	$172,738

Source: NMFS SEFSC Logbook and ALS data.
*Includes Gulf trips on which greater amberjack were not harvested and trips in the South Atlantic on which greater amberjack may have been harvested.

Table 3.3.1.11. Summary of vessel counts, trips, and logbook landings (pounds gutted weight (lbs gw)) or vessels landing at least one pound of vermilion snapper, 2011-2015.

Year	Number of Vessels	Number of Gulf Trips on which Vermilion Snapper were Caught	Vermilion Snapper Landings (lbs gw)	"Other Species" Landings Jointly Caught with Vermilion Snapper (lbs gw)	Number of Other Trips*	Landings on Other Trips (lbs gw)
2011	342	2,737	2,596,301	5,081,963	2,032	4,511,937
2012	342	2,817	2,029,275	5,730,819	2,405	4,698,620
2013	315	2,392	1,164,105	5,749,040	2,102	4,542,235
2014	347	2,677	1,407,221	6,409,798	2,652	6,086,523
2015	351	2,568	1,172,468	6,823,897	2,742	5,736,823
Average	339	2,638	1,673,874	5,959,103	2,387	5,115,228

Source: NMFS SEFSC Logbook data.
*Includes Gulf trips on which vermilion snapper were not harvested and trips in the South Atlantic on which vermilion snapper may have been harvested.

Table 3.3.1.12. Summary of vessel counts and revenue (2015 dollars) for vessels landing at least one pound of vermilion snapper, 2011-2015.

Year	Number of Vessels	Dockside Revenue from Vermilion Snapper	Dockside Revenue from "Other Species" Jointly Caught with Vermilion Snapper	Dockside Revenue on Other Trips*	Total Dockside Revenue	Average Total Dockside Revenue per Vessel
2011	342	$7,883,866	$16,483,844	$14,055,440	$38,423,150	$112,348
2012	342	$6,340,718	$19,722,568	$15,349,188	$41,412,474	$121,089
2013	315	$3,737,027	$22,413,379	$16,699,675	$42,850,081	$136,032
2014	347	$4,342,898	$25,119,479	$22,756,110	$52,218,487	$150,486
2015	351	$4,080,313	$28,216,212	$22,272,642	$54,569,167	$155,468
Average	339	$5,276,964	$22,391,096	$18,226,611	$45,894,672	$135,085

Source: NMFS SEFSC Logbook and ALS data.
*Includes Gulf trips on which vermilion snapper were not harvested and trips in the South Atlantic on which vermilion snapper may have been harvested.

Ex-vessel Prices

The dockside or ex-vessel price is the price the vessel receives at the first sale of harvest. Over the period 2011-2015, the average annual ex-vessel price per lb (2015 dollars) for the species examined were: $3.74 (all reef fish species combined); $3.79 (grouper-tilefish); $4.32 red snapper; $1.78 (gray triggerfish); $1.43 (greater amberjack); and $3.15 (vermilion snapper).

Commercial Sector Business Activity

Estimates of the business activity (economic impacts) in the U.S. associated with the commercial harvest of species in the reef fish FMU were derived using the model developed for and applied in NMFS (2015) and are provided in Table 3.3.1.13. Business activity for the commercial sector is characterized in the form of jobs (full- and part-time), output (sales) impacts (gross business sales), income impacts (wages, salaries, and self-employed income), and value added impacts (difference between the sales price of a good and the cost of the goods and services needed to produce it). Income impacts should not be added to output (sales) impacts because this would result in double counting. The estimates of economic activity include the direct effects (effects in the sector where an expenditure is actually made), indirect effects (effects in sectors providing goods and services to directly affected sectors), and induced effects (effects induced by the personal consumption expenditures of employees in the direct and indirectly affected sectors).

Table 3.3.1.13. Average annual business activity associated with the harvests of vessels that harvest reef fish, 2010-2015.

Species	Average Annual Dockside Revenue (thousands)[1]	Jobs	Output (Sales) Impacts (thousands)[1]	Income Impacts (thousands)[1]	Value Added Impacts (thousands)[1]
Reef Fish	$53.10	7,223	$526,588	$193,382	$273,225
All species[2]	$57.51	7,822	$570,262	$209,420	$295,887

[1]2015 dollars.
[2]Includes dockside revenues and economic activity associated with the average annual harvests of all species, including reef fish, harvested by vessels that harvested reef fish in the Gulf.

As discussed above, vessels that harvested species in the reef fish FMU also harvested other species on trips where reef fish were harvested, and some took other trips in the Gulf on which no reef fish were harvested, as well as trips in the South Atlantic. All revenues from all species harvested on all of these trips contributed towards making these vessels economically viable and contribute to the economic activity associated with these vessels. The average annual total ex-vessel revenues from all species harvested during this period (2011-2015) by vessels that harvested species in the reef fish FMU was approximately $57.51 million (2015 dollars; Table 3.3.1.13). The business activity associated with this revenue is estimated to support approximately 7,800 full time equivalent (FTE) jobs and is associated with approximately $570.26 million in output (sales) impacts, approximately $209.42 million in income impacts, and approximately $295.89 million in value added impacts. Similar information for business activity associated just with the harvest of the grouper-tilefish LAPP species and the individual reef fish species discussed above has not been calculated. However, the information in Table 3.3.1.13 can be used to generate the appropriate ratios of impact per dollar of revenue. Because these are average ratios and not specific to individual species within the reef fish FMU, they can be combined with the revenue estimates for the individual reef fish species or species group to calculate the business activity associated with these portions of the reef fish fishery.

Dealers

Commercial vessels landing reef fish can only sell their catch to federally permitted fish dealers. On September 29, 2016, 411 dealers possessed the necessary federal dealer permit to receive reef fish harvested in the Gulf. There are no income or sales requirements to acquire a federal dealer permit. As a result, the total number of dealers can vary over the course of the year and from year to year.

Imports

Information on the imports of all snapper and grouper species, either fresh or frozen, are available at: http://www.st.nmfs.noaa.gov/st1/trade/cumulative_data/TradeDataProduct.html. Information on the imports of individual snapper or grouper species is not available. In 2012, imports of all snapper and grouper species (fresh and frozen) were approximately 44.51 million pounds valued at approximately $138.81 million (2014 dollars). More recent data is not currently available. These amounts are contrasted with the domestic harvest of all snapper and grouper in the U.S. in 2014 of approximately 20.32 mp valued at approximately $78.80 million (2014 dollars; data available at: http://www.st.nmfs.noaa.gov/commercial-fisheries/publications/index). Although the levels of domestic production and imports are not totally comparable for several reasons, including considerations of different product form such as fresh versus frozen, and possible product mislabeling, the difference in the magnitude of imports relative to amount of domestic harvest is indicative of the dominance of imports in the domestic market.

3.3.2 Recreational Sector

Angler Effort

Recreational effort derived from the Marine Recreational Information Program (MRIP) database can be characterized in terms of the number of trips as follows:

- Target effort – The number of individual angler trips, regardless of duration, where the intercepted angler indicated that the species or a species in the species group was targeted as either the first or second primary target for the trip. The species did not have to be caught.
- Catch effort – The number of individual angler trips, regardless of duration and target intent, where the individual species or a species in the species group was caught. The fish did not have to be kept.
- Total recreational trips – The total estimated number of recreational trips in the Gulf, regardless of target intent or catch success.

Other measures of effort are possible, such as directed trips (the number of individual angler trips that either targeted or caught a particular species), among other measures. Estimates of the number of target trips and catch trips for the shore, charter, and private/rental boat modes in the Gulf, 2011-2015, for all species in the reef fish FMU and select individual species are provided in Tables 3.3.2.1-3.3.2.14. The data for the individual species should not be added because double counting may occur (i.e., a trip that targets or catches one reef fish species could also target or catch another reef fish species). Because these estimates are survey-based, they may be more useful in demonstrating trends and ranking across modes rather than documenting absolute amounts of activity. The absence of recorded target or catch trips for some species in all year-state-mode combinations may more indicative of low effort rather than the absence of any effort for those species. This is particularly the case when effort is positive in some but not all years.

Although, there are 31 species in the reef fish FMU, only 15 species had recorded target effort during 2011-2015 in the MRIP data (alphabetically, black grouper, gag, goliath grouper, gray snapper, gray triggerfish, greater amberjack, lane snapper, mutton snapper, red grouper, red snapper, scamp, vermilion snapper, hogfish, and yellowtail snapper). Detailed information for hogfish is found in GMFMC (2016a). The average number of reef fish target trips per year across all states and modes was approximately 1.43 million (Table 3.3.2.1), or approximately 6.1% of the total annual average of trips taken (approximately 23.21 million trips; total trips taken, by state or mode; percentages not included in the Table 3.3.2.1 or subsequent tables).

The average annual number of reef fish catch trips for this period was 3.10 million (Table 3.3.2.2). Among the individual species examined, red snapper was the most commonly targeted or caught species (approximately 415,000 and 620,000 trips, respectively; Tables 3.3.2.3 and 3.3.2.4), followed by gag (approximately 275,000 target trips and 469,000 catch trips), and red grouper (approximately 269,000 target trips and 491,00 catch trips; Tables 3.3.2.5 and 3.3.2.6).

Table 3.3.2.1. Number of reef fish recreational target trips, by state and mode, 2011-2015*.

Year	Alabama	West Florida	Louisiana	Mississippi	Total
	Shore Mode				
2011	808	110,405	nr	nr	111,213
2012	8,177	113,758	nr	nr	121,935
2013	1,612	155,702	nr	nr	157,314
2014	2,064	241,095	na	nr	243,159
2015	8,665	158,377	na	nr	167,042
Average	4,265	155,867	na/nr	nr	160,133
	Charter Mode				
2011	22,996	90,873	2,884	nr	116,753
2012	17,258	130,884	9,648	74	157,864
2013	26,953	133,038	9,793	38	169,822
2014	14,444	94,693	na	nr	109,137
2015	27,299	158,214	na	366	185,879
Average	22,239	115,652	7,442	138	145,470
	Private/Rental Mode				
2011	133,462	560,919	28,051	16,790	739,222
2012	76,050	716,265	52,137	13,515	857,967
2013	232,280	1,454,797	36,961	21,713	1,745,751
2014	68,919	1,086,201	na	8,864	1,163,984
2015	140,490	844,223	na	4,199	988,912
Average	129,786	919,808	39,050	13,010	1,101,653
	All Modes				
2011	157,266	762,197	30,935	16,790	967,188
2012	101,485	960,907	61,785	13,589	1,137,766
2013	260,845	1,743,537	46,754	21,751	2,072,887
2014	85,427	1,421,989	na	8,864	1,516,280
2015	176,454	1,160,814	na	4,565	1,341,833
Average	156,295	1,209,889	46,491	13,112	1,425,787

* "na" = not available; "nr" = none recorded. Averages based on positive entries; "nr" entries are not assumed equivalent to "0" trips. Texas information unavailable. Source: MRIP database, NMFS, SERO.
Note: These effort estimates have not been re-calibrated. Re-calibrated effort data are currently unavailable.

Table 3.3.2.2. Number of reef fish recreational catch trips, by state and mode, 2011-2015*.

Year	Alabama	West Florida	Louisiana	Mississippi	Total
	Shore Mode				
2011	7,153	367,738	1,062	nr	375,953
2012	31,803	462,697	5,761	16,233	516,494
2013	31,876	679,368	13,017	1,389	725,650
2014	7,487	677,045	na	nr	684,532
2015	7,965	627,264	na	nr	635,229
Average	17,257	562,822	6,613	8,811	595,504
	Charter Mode				
2011	50,361	279,193	5,354	221	335,129
2012	30,207	368,484	14,155	283	413,129
2013	59,524	420,112	14,838	384	494,858
2014	51,884	397,911	na	742	450,537
2015	56,762	452,184	na	366	509,312
Average	49,748	383,577	11,449	399	445,173
	Private/Rental Mode				
2011	140,914	1,109,567	50,654	6,169	1,307,304
2012	130,738	1,509,459	91,644	28,806	1,760,647
2013	245,040	2,379,210	79,027	81,370	2,784,647
2014	129,197	2,207,309	na	10,552	2,347,058
2015	191,072	1,772,526	na	28,089	1,991,687
Average	167,392	1,795,614	73,775	30,997	2,067,779
	All Modes				
2011	198,428	1,756,498	57,070	6,390	2,018,386
2012	192,748	2,340,640	111,560	45,322	2,690,270
2013	336,440	3,478,690	106,882	83,143	4,005,155
2014	188,568	3,282,265	na	11,294	3,482,127
2015	255,799	2,851,974	na	28,455	3,136,228
Average	234,397	2,742,013	91,837	34,921	3,103,168

* “na” = not available; “nr” = none recorded. Averages based on positive entries; “nr” entries are not assumed equivalent to “0” trips. Texas information unavailable. Source: MRIP database, NMFS, SERO.
Note: These effort estimates have not been re-calibrated. Re-calibrated effort data are currently unavailable.

Table 3.3.2.3. Number of red snapper recreational target trips, by state and mode, 2011-2015*.

Year	Alabama	West Florida	Louisiana	Mississippi	Total
	Charter Mode				
2011	19,010	29,642	1,424	nr	50,076
2012	16,609	24,653	7,204	74	48,540
2013	23,638	32,689	7,191	38	63,556
2014	9,050	7,358	na	nr	16,408
2015	24,182	53,363	na	366	77,911
Average	18,498	29,541	5,273	159	53,471
	Private/Rental Mode				
2011	116,886	113,021	19,900	16,790	266,597
2012	72,030	136,594	43,547	13,515	265,686
2013	222,245	461,349	24,691	21,586	729,871
2014	56,918	165,498	na	7,555	229,971
2015	117,736	134,155	na	4,199	256,090
Average	116,900	201,805	29,379	12,723	360,807
	All Modes				
2011	135,896	142,663	21,324	16,790	316,673
2012	88,640	161,247	50,751	13,589	314,227
2013	245,883	494,038	31,882	21,624	793,427
2014	65,968	172,856	na	7,555	246,379
2015	141,918	187,518	na	4,565	334,001
Average	135,661	231,664	34,652	12,825	414,802

* "na" = not available; "nr" = none recorded. Averages based on positive entries; "nr" entries are not assumed equivalent to "0" trips. Texas information unavailable. Source: MRIP database, NMFS, SERO.
Note: These effort estimates have not been re-calibrated. Re-calibrated effort data are currently unavailable.

Table 3.3.2.4. Number of red snapper recreational catch trips, by state and mode, 2011-2015*.

Year	Alabama	West Florida	Louisiana	Mississippi	Total
	Charter Mode				
2011	43,550	101,500	3,066	221	148,337
2012	25,252	105,385	10,501	74	141,212
2013	52,331	107,466	12,321	38	172,156
2014	36,340	66,559	na	nr	102,899
2015	45,735	116,073	na	366	162,174
Average	40,642	99,397	8,629	175	145,356
	Private/Rental Mode				

2011	130,500	203,567	31,957	6,169	372,193
2012	83,783	282,332	51,377	13,515	431,007
2013	227,889	537,469	55,679	29,250	850,287
2014	110,593	233,265	na	10,254	354,112
2015	149,284	198,529	na	18,038	365,851
Average	140,410	291,032	46,338	15,445	474,690
	All Modes				
2011	174,050	305,067	35,023	6,390	520,530
2012	109,035	387,717	61,878	13,589	572,219
2013	280,221	644,935	68,000	29,288	1,022,444
2014	146,933	299,824	na	10,254	457,011
2015	195,019	314,602	na	18,404	528,025
Average	181,052	390,429	54,967	15,585	620,046

* "na" = not available; "nr" = none recorded. Averages based on positive entries; "nr" entries are not assumed equivalent to "0" trips. Texas information unavailable. Source: MRIP database, NMFS, SERO.
Note: These effort estimates have not been re-calibrated. Re-calibrated effort data are currently unavailable.

Table 3.3.2.5. Number of red grouper recreational target trips, West Florida, by mode, 2011-2015*.

West Florida				
Year	**Shore Mode**	**Charter Mode**	**Private/Rental Mode**	**All Modes**
2011	3,387	27,704	131,471	162,562
2012	263	50,669	207,099	258,031
2013	5,723	52,264	344,622	402,609
2014	13,151	38,616	240,456	292,223
2015	nr	57,698	164,802	222,500
Average	5,631	45,390	217,690	268,711

*Red grouper target trips in the Gulf were only recorded in West Florida. "na" = not available; "nr" = none recorded. Averages based on positive entries; "nr" entries are not assumed equivalent to "0" trips. Source: MRIP database, NMFS, SERO.
Note: These effort estimates have not been re-calibrated. Re-calibrated effort data are currently unavailable.

Table 3.3.2.6. Number of red grouper recreational catch trips, by state and mode, 2011-2015*.

Year	**Alabama**	**West Florida**	**Total**
	Shore Mode		
2011	nr	2,030	2,030
2012	nr	1,711	1,711
2013	nr	1,701	1,701

2014	nr	3,087	3,087
2015	nr	9,390	9,390
Average	nr	3,584	3,584
	Charter Mode		
2011	nr	99,195	99,195
2012	606	132,620	133,226
2013	3,472	136,587	140,059
2014	118	126,144	126,262
2015	2,044	128,747	130,791
Average	1,560	124,659	126,219
	Private/Rental Mode		
2011	nr	271,990	271,990
2012	nr	363,310	363,310
2013	1,736	449,527	451,263
2014	1,933	394,685	396,618
2015	652	321,079	321,731
Average	1,440	360,118	361,559
	All Modes		
2011	nr	373,215	373,215
2012	606	497,641	498,247
2013	5,208	587,815	593,023
2014	2,051	523,916	525,967
2015	2,696	459,216	461,912
Average	2,640	488,361	491,001

* "na" = not available; "nr" = none recorded. Averages based on positive entries; "nr" entries are not assumed equivalent to "0" trips. Texas information unavailable. Source: MRIP database, NMFS, SERO.
Note: These effort estimates have not been re-calibrated. Re-calibrated effort data are currently unavailable.

Table 3.3.2.7. Number of gag recreational target trips, by state and mode, 2011-2015*.

Year	Alabama	West Florida	Mississippi	Total
	Shore Mode			
2011	nr	26,233	nr	26,233
2012	nr	10,269	nr	10,269
2013	nr	32,956	nr	32,956
2014	nr	6,238	nr	6,238
2015	nr	2,380	nr	2,380
Average	nr	15,615	nr	15,615
	Charter Mode			

2011	433	5,357	nr	5,790
2012	nr	26,271	nr	26,271
2013	138	19,799	nr	19,937
2014	nr	15,447	nr	15,447
2015	348	3,840	nr	4,188
Average	306	14,143	nr	14,449
	Private/Rental Mode			
2011	nr	186,536	nr	186,536
2012	nr	185,396	nr	185,396
2013	1,146	417,054	127	418,327
2014	nr	244,591	906	245,497
2015	645	129,195	nr	129,840
Average	896	232,554	517	233,966
	All Modes			
2011	433	218,126	nr	218,559
2012	nr	221,936	nr	221,936
2013	1,284	469,809	127	471,220
2014	nr	266,276	906	267,182
2015	993	135,415	nr	136,408
Average	903	262,312	517	263,732

* "na" = not available; "nr" = none recorded. Averages based on positive entries; "nr" entries are not assumed equivalent to "0" trips. Texas information unavailable. Source: MRIP database, NMFS, SERO.
Note: These effort estimates have not been re-calibrated. Re-calibrated effort data are currently unavailable.

Table 3.3.2.8. Number of gag recreational catch trips, by state and mode, 2011-2015*.

Year	Alabama	West Florida	Louisiana	Mississippi	Total
	Shore Mode				
2011	nr	65,239	nr	nr	65,239
2012	705	49,354	nr	nr	50,059
2013	nr	34,171	nr	nr	34,171
2014	nr	51,228	na	nr	51,228
2015	nr	22,550	na	nr	22,550
Average	705	44,508	na/nr	nr	45,213
	Charter Mode				
2011	395	70,039	102	nr	70,536
2012	1,024	115,203	665	nr	116,892
2013	1,960	114,284	nr	nr	116,244
2014	580	55,016	na	nr	55,596

2015	540	36,453	na	nr	36,993
Average	900	78,199	384	nr	79,482
	Private/Rental Mode				
2011	3,559	308,274	12,147	nr	323,980
2012	2,492	319,990	4,518	nr	327,000
2013	7,386	449,991	503	1,739	459,619
2014	1,025	356,753	na	nr	357,778
2015	625	172,137	na	430	173,192
Average	3,017	321,429	5,723	1,085	331,254
	All Modes				
2011	3,954	443,552	12,249	nr	459,755
2012	4,221	484,547	5,183	nr	493,951
2013	9,346	598,446	503	1,739	610,034
2014	1,605	462,997	na	nr	464,602
2015	1,165	231,140	na	430	232,735
Average	4,058	444,136	5,978	1,085	455,257

* "na" = not available; "nr" = none recorded. Averages based on positive entries; "nr" entries are not assumed equivalent to "0" trips. Texas information unavailable. Source: MRIP database, NMFS, SERO.
Note: These effort estimates have not been re-calibrated. Re-calibrated effort data are currently unavailable.

Table 3.3.2.9. Number of gray triggerfish recreational target trips, by state and mode, 2011-2015*.

Year	Alabama	West Florida	Total
	Charter Mode		
2011	1,138	2,046	3,184
2012	47	743	790
2013	131	822	953
2014	nr	557	557
2015	nr	nr	nr
Average	439	1,042	1,481
	Private/Rental Mode		
2011	8,852	12,612	21,464
2012	1,959	11,654	13,613
2013	7,341	18,894	26,235
2014	930	20,049	20,979
2015	2,464	4,775	7,239
Average	4,309	13,597	17,906
	All Modes		

2011	9,990	14,658	24,648
2012	2,006	12,397	14,403
2013	7,472	19,716	27,188
2014	930	20,606	21,536
2015	2,464	4,775	7,239
Average	4,572	14,430	19,003

* "na" = not available; "nr" = none recorded. Averages based on positive entries; "nr" entries are not assumed equivalent to "0" trips. Texas information unavailable. Source: MRIP database, NMFS, SERO.
Note: These effort estimates have not been re-calibrated. Re-calibrated effort data are currently unavailable.

Table 3.3.2.10. Number of gray triggerfish recreational catch trips, by state and mode, 2011-2015*.

Year	Alabama	West Florida	Louisiana	Mississippi	Total
	Shore Mode				
2011	nr	956	1,062	nr	2,018
2012	nr	2,497	nr	nr	2,497
2013	nr	1,854	nr	nr	1,854
2014	nr	2,586	na	nr	2,586
2015	nr	nr	na	nr	0
Average	nr	1,973	na/nr	nr	1,973
	Charter Mode				
2011	28,803	83,719	1,112	nr	113,634
2012	4,801	48,887	nr	nr	53,688
2013	21,658	56,763	425	38	78,884
2014	9,882	54,890	na	nr	64,772
2015	13,137	44,020	na	nr	57,157
Average	15,656	57,656	769	38	74,119
	Private/Rental Mode				
2011	29,452	75,307	nr	nr	104,759
2012	6,602	79,707	7,807	nr	94,116
2013	16,438	165,205	7,125	nr	188,768
2014	8,017	115,366	na	nr	123,383
2015	19,259	116,854	na	372	136,485
Average	15,954	110,488	7,466	372	134,279
	All Modes				
2011	58,255	159,982	2,174	nr	220,411
2012	11,403	131,091	7,807	nr	150,301
2013	38,096	223,822	7,550	38	269,506

2014	17,899	172,842	na	nr	190,741
2015	32,396	160,874	na	372	193,642
Average	31,610	169,722	5,844	205	207,381

* "na" = not available; "nr" = none recorded. Averages based on positive entries; "nr" entries are not assumed equivalent to "0" trips. Texas information unavailable. Source: MRIP database, NMFS, SERO.
Note: These effort estimates have not been re-calibrated. Re-calibrated effort data are currently unavailable.

Table 3.3.2.11. Number of greater amberjack recreational target trips, by state and mode, 2011-2015*.

Year	Alabama	West Florida	Louisiana	Mississippi	Total
	Charter Mode				
2011	1,813	13,566	186	nr	15,565
2012	280	8,067	2,031	nr	10,378
2013	2,199	9,207	50	nr	11,456
2014	3,564	4,742	na	nr	8,306
2015	1,776	10,443	na	nr	12,219
Average	1,926	9,205	756	nr	11,887
	Private/Rental Mode				
2011	6,061	13,982	nr	nr	20,043
2012	2,061	23,114	621	nr	25,796
2013	2,549	31,901	5,101	nr	39,551
2014	6,077	42,536	na	226	48,839
2015	18,335	72,398	na	nr	90,733
Average	7,017	36,786	2,861	226	46,890
	All Modes				
2011	7,874	27,548	186	nr	35,608
2012	2,341	31,181	2,652	nr	36,174
2013	4,748	41,108	5,151	nr	51,007
2014	9,641	47,278	na	226	57,145
2015	20,111	82,841	na	nr	102,952
Average	8,943	45,991	2,663	226	57,823

* "na" = not available; "nr" = none recorded. Averages based on positive entries; "nr" entries are not assumed equivalent to "0" trips. Texas information unavailable. Source: MRIP database, NMFS, SERO.
Note: These effort estimates have not been re-calibrated. Re-calibrated effort data are currently unavailable.

Table 3.3.2.12. Number of greater amberjack recreational catch trips, by state and mode, 2011-2015*.

Year	Alabama	West Florida	Louisiana	Mississippi	Total
	Shore Mode				

2011	4,478	445	nr	nr	4,923
2012	nr	470	nr	nr	470
2013	nr	205	nr	nr	205
2014	nr	3,589	na	nr	3,589
2015	1,439	nr	na	nr	1,439
Average	2,959	1,177	na/nr	nr	4,136
	Charter Mode				
2011	5,507	44,654	1,474	nr	51,635
2012	2,247	44,519	4,917	nr	51,683
2013	7,492	44,174	3,444	nr	55,110
2014	1,449	37,201	na	nr	38,650
2015	10,970	47,725	na	nr	58,695
Average	5,533	43,655	3,278	nr	52,466
	Private/Rental Mode				
2011	7,905	41,980	3,295	nr	53,180
2012	3,553	59,874	4,572	nr	67,999
2013	7,364	103,597	7,348	2,356	120,665
2014	12,643	63,288	na	226	76,157
2015	16,658	83,587	na	nr	100,245
Average	9,625	70,465	5,072	1,291	86,452
	All Modes				
2011	nr	87,079	4,769	nr	91,848
2012	2,247	104,863	9,489	nr	116,599
2013	14,856	147,976	10,792	2,356	175,980
2014	14,092	104,078	na	226	118,396
2015	27,628	131,312	na	nr	158,940
Average	14,706	115,062	8,350	1,291	139,408

* “na” = not available; “nr” = none recorded. Averages based on positive entries; “nr” entries are not assumed equivalent to “0” trips. Texas information unavailable. Source: MRIP database, NMFS, SERO.
Note: These effort estimates have not been re-calibrated. Re-calibrated effort data are currently unavailable.

Table 3.3.2.13. Number of vermilion snapper recreational target trips, by state and mode, 2011-2015*.

Year	Alabama	West Florida	Total
	Charter Mode		
2011	2,992	3,003	5,995
2012	631	1,449	2,080
2013	2,877	93	2,970

2014	1,394	6,005	7,399
2015	1,239	2,507	3,746
Average	1,827	2,611	4,438
	Private/Rental Mode		
2011	7,809	9,675	17,484
2012	705	8,487	9,192
2013	5,944	13,150	19,094
2014	5,994	13,744	19,738
2015	2,958	25,365	28,323
Average	4,682	14,084	18,766
	All Modes		
2011	10,801	12,678	23,479
2012	1,336	9,936	11,272
2013	8,821	13,243	22,064
2014	7,388	19,749	27,137
2015	4,197	27,872	32,069
Average	6,509	16,696	23,204

* "na" = not available; "nr" = none recorded. Averages based on positive entries; "nr" entries are not assumed equivalent to "0" trips. Texas information unavailable. Source: MRIP database, NMFS, SERO.
Note: These effort estimates have not been re-calibrated. Re-calibrated effort data are currently unavailable.

Table 3.3.2.14. Number of vermilion snapper recreational catch trips, by state and mode, 2011-2015*.

Year	Alabama	West Florida	Louisiana	Total
	Charter Mode			
2011	26,704	88,680	nr	115,384
2012	7,855	67,405	nr	75,260
2013	16,917	91,795	nr	108,712
2014	26,031	91,927	na	117,958
2015	16,281	83,255	na	99,536
Average	18,758	84,612	na/nr	103,370
	Private/Rental Mode			
2011	17,067	50,908	nr	67,975
2012	2,828	63,268	nr	66,096
2013	24,900	127,153	3,557	155,610
2014	14,258	90,756	na	105,014
2015	11,583	82,887	na	94,470
Average	14,127	82,994	3,557	100,679

	All Modes			
2011	43,771	139,588	nr	183,359
2012	10,683	130,673	nr	141,356
2013	41,817	218,948	3,557	264,322
2014	40,289	182,683	na	222,972
2015	27,864	166,142	na	194,006
Average	32,885	167,607	3,557	204,049

* "na" = not available; "nr" = none recorded. Averages based on positive entries; "nr" entries are not assumed equivalent to "0" trips. Texas information unavailable. Source: MRIP database, NMFS, SERO.
Note: These effort estimates have not been re-calibrated. Re-calibrated effort data are currently unavailable.

Similar analysis of recreational effort is not possible for the headboat mode because headboat data are not collected at the angler level. Estimates of effort by the headboat mode are provided in terms of angler days, or the number of standardized 12-hour fishing days that account for the different half-, three-quarter-, and full-day fishing trips by headboats. The stationary "fishing for demersal (bottom-dwelling) species" nature of headboat fishing, as opposed to trolling, suggests that most, if not all, headboat trips and, hence, angler days, are demersal or reef fish trips by intent.

The distribution of headboat effort (angler days) by geographic area is presented in Table 3.3.2.15. For purposes of data collection, the headboat data collection program divides the Gulf into several areas. On average (2011 through 2015), the area from the Dry Tortugas through the Florida Middle Grounds accounted for 40.5% of total headboat angler days in the Gulf, followed by northwest Florida through Alabama (35.4%), Texas (22.5%), and Mississippi through Louisiana (1.5%). Western Florida experienced a steady increase over that time period to a five-year high in 2015.

Table 3.3.2.15. Headboat angler days and percent distribution, by state, 2011-2015.

	Angler Days				Percent Distribution			
Year	**FLW**	**NWFL-AL***	**MS-LA****	**TX**	**FLW**	**FL-AL**	**MS-LA**	**TX**
2011	79,722	77,303	3,657	47,284	38.3%	37.2%	1.8%	22.7%
2012	84,205	77,770	3,680	51,776	38.7%	35.8%	1.7%	23.8%
2013	94,752	80,048	3,406	55,749	40.5%	34.2%	1.5%	23.8%
2014	102,841	88,524	3,257	51,231	41.8%	36.0%	1.3%	20.8%
2015	107,910	86,473	3,587	55,135	42.6%	34.2%	1.4%	21.8%
Average	93,886	82,024	3,517	52,235	40.5%	35.4%	1.5%	22.5%

Source: NMFS Southeast Region Headboat Survey (SRHS).
*Beginning in 2013, HBS data was reported separately for NW Florida and Alabama, but has been combined here for consistency with previous years.
**Headboat data from Mississippi and Louisiana are combined for confidentiality purposes.

Permits

The for-hire sector is comprised of charter vessels and headboats (party boats). Although charter vessels tend to be smaller, on average, than headboats, the key distinction between the two types of operations is how the fee is determined. On a charter boat trip, the fee charged is for the entire vessel, regardless of how many passengers are carried, whereas the fee charged for a headboat trip is paid per individual angler.

A federal charter/headboat (for-hire) vessel permit is required for fishing in federal waters for Gulf reef fish. On October 5, 2016, there were 1,309 vessels with a valid (non-expired) or renewable Gulf for-hire reef fish permit (including historical captain permits). A renewable permit is an expired limited access permit that cannot be actively fished, but is renewable for up to one year after expiration. The Gulf reef fish for-hire permits are limited access permits. Most for-hire vessels possess more than one for-hire permit.

Although the for-hire permit application collects information on the primary method of operation, the permit itself does not identify the permitted vessel as either a headboat or a charter vessel and vessels may operate in both capacities. However, if a vessel meets the selection criteria used by the Southeast Region Headboat Survey (SRHS) and is selected to report by the Science Research Director (SRD) of the Southeast Fishery Science Center (SEFSC), it is determined to operate primarily as a headboat and is required to submit harvest and effort information to the SRHS. As of September 2016, 67 federally permitted Gulf headboats were registered in the SRHS (K. Fitzpatrick, NMFS SEFSC, pers. comm.).

Information on Gulf charter vessel and headboat operating characteristics is included in Savolainen et al. (2012) and is incorporated herein by reference. The average charter vessel operation took 46 full-day (9 hours) and 55 half-day (5 hours) trips per year, carried 4.8 and 4.6 passengers per trip type, respectively, targeted reef fish and pelagic species on 64% and 19% of all trips, respectively, and took 68% of all trips in the Exclusive Economic Zone (EEZ). The average headboat operation took 83 full-day (10 hours) and 37 half-day (6 hours) trips per year, carried 13.1 and 14.6 passengers per trip type, respectively, targeted reef fish and pelagic species on 84% and 6% of all trips, respectively, and took 81% of all trips in the EEZ.

There are no specific federal permitting requirements for recreational anglers to fish for or harvest reef fish. Instead, anglers are required to possess either a state recreational fishing permit that authorizes saltwater fishing in general, or be registered in the federal National Saltwater Angler Registry system, subject to appropriate exemptions. For the for-hire sector, customers are authorized to fish under the charter or headboat vessel license and are not required to hold their own fishing licenses. As a result, it is not possible to identify with available data how many individual anglers would be expected to be affected by this proposed action.

Economic Value

Economic value can be measured in the form of consumer surplus (CS) per additional red snapper kept on a trip for anglers (the amount of money that an angler would be willing to pay for a fish in excess of the cost to harvest the fish). The estimated value of the CS per fish is not available for many Gulf reef fish species. However, some representative estimates for the more popular species are approximately $82 for red snapper and $104 for grouper for a second fish caught and kept on a trip (Carter and Liese 2012; values updated to 2015 dollars).

Economic value for for-hire vessels can be measured by producer surplus (PS) per passenger trip (the amount of money that a vessel owner earns in excess of the cost of providing the trip). Estimates of the PS per for-hire passenger trip are not available. Instead, net operating revenue (NOR), which is the return used to pay all labor wages, returns to capital, and owner profits, is used as a proxy for PS. For vessels in the Gulf, the estimated NOR value is approximately $155 (2015 dollars) per angler trip in charterboats (Carter and Liese 2011). The estimated NOR value per angler trip in headboats is approximately $54 (2015 dollars) (C. Liese, NMFS SEFSC, pers. comm.).

Business Activity

The desire for recreational fishing generates economic activity as consumers spend their income on various goods and services needed for recreational fishing. This spurs economic activity in the region where recreational fishing occurs. It should be clearly noted that, in the absence of the opportunity to fish, the income would presumably be spent on other goods and services and these expenditures would similarly generate economic activity in the region where the expenditure occurs. As such, the analysis below represents a distributional analysis only.

Estimates of the business activity (economic impacts) associated with recreational angling for reef fish were derived using average impact coefficients for recreational angling for all species, as derived from an add-on survey to the Marine Recreational Fisheries Statistics Survey (MRFSS) to collect economic expenditure information, as described and utilized in NMFS (2015). Estimates of the average expenditures by recreational anglers are also provided in NMFS (2015) and are incorporated herein by reference.

Recreational fishing generates business activity (economic impacts). Business activity for the recreational sector is characterized in the form of jobs (full- and part-time), output (sales) impacts (gross business sales), income impacts, and value-added impacts (difference between the value of goods and the cost of materials or supplies). Estimates of the average reef fish target effort (2011-2015) and associated business activity (2015 dollars) are provided in Table 3.3.2.16.

The estimates provided in Table 3.3.2.16 only apply at the state-level. For example, estimates of business activity in Florida represent business activity in Florida only and not to other states (for example, a good purchased in Florida may have been manufactured in a neighboring state) or the nation as a whole. The same holds true for each of the other states.

Estimates of the business activity associated with headboat effort are not available. Headboat vessels are not covered in the MRFSS/MRIP so, in addition to the absence of estimates of target effort, estimation of the appropriate business activity coefficients for headboat effort has not been conducted.

Table 3.3.2.16. Summary of reef fish target trips (2011-2015 average) and associated business activity (thousand 2015 dollars). Output, value added, and income impacts are not additive.

	FL	AL	MS	LA	TX*
	Charter Mode				
Target Trips	383,577	49,748	399	11,449	*
Value Added Impacts	$160,037	$15,560	$89	$3,796	*
Output Impacts	$263,166	$28,761	$182	$6,230	*
Income Impacts	$111,362	$11,261	$63	$2,889	*
Jobs	2,437	326	2	56	*
	Private/Rental Mode				
Target Trips	1,795,614	167,392	73,775	30,997	*
Value Added Impacts	$57,451	$4,766	$1,368	$1,283	*
Output Impacts	$90,767	$8,265	$2,447	$2,226	*
Income Impacts	$34,759	$2,881	$800	$694	*
Jobs	858	93	24	18	*
	Shore				
Target Trips	562,822	17,257	6,613	8,811	*
Value Added Impacts	$15,958	$635	$55	$270	*
Output Impacts	$25,558	$1,122	$99	$479	*
Income Impacts	$9,693	$388	$33	$147	*
Jobs	256	13	1	4	*
	All Modes				
Target Trips	2,742,013	234,397	80,787	51,257	*
Value Added Impacts	$233,446	$20,962	$1,511	$5,348	*
Output Impacts	$379,492	$38,148	$2,728	$8,935	*
Income Impacts	$155,813	$14,530	$896	$3,730	*
Jobs	3,551	432	28	78	*

*Because target information is unavailable, associated business activity cannot be calculated.
Source: effort data from the MRIP, economic impact results calculated by NMFS SERO using the model developed for NMFS (2015).

3.4 Description of the Social Environment

The action of this amendment establishes or modifies thresholds for determining whether a reef fish species is overfished. Because this action affects reef fish generally, but does not directly affect the harvest or customary use of reef fish, the description of the social environment provides a broad look at commercial and recreational fishing in the Gulf. A portion of the description examines commercial and recreational fishing engagement at the county level. This is followed by a more specific focus on the communities within each Gulf coast county that have concentrated reef fish permits (commercial and charter).

3.4.1 Coastal Counties

Commercial and recreational fishing engagement and reliance are measures of fishing activity at the county level developed from federal fisheries datasets. Commercial and recreational fishing engagements are measures of fishing activity as measured by the absolute numbers of that activity. For commercial fishing, engagement is based on the number of commercial vessels by homeport address, number of commercial vessels by owner's address, and number of dealers with landings in each county. Recreational engagement uses the number of recreational vessels by homeport address, number of recreational vessels by owner's address, and number of recreational infrastructure (boat ramps associated with a community) in each county. The commercial and recreational reliance indices are relative measures consisting of the same variables related to commercial or recreational fishing activity, but divided by the population of the community. A principal component analysis with a single factor solution is then run on these variables. The factor score becomes the engagement or reliance score for a community (the scores are standardized and zero is the mean, which are then categorized by standard deviation: Low = less than 0.0 to 0.0; Medium = greater than 0.0 to 0.5; Medium high = greater than 0.5 to 1.0; High = greater than 1.0).

Commercial Engagement and Reliance

Each Gulf state in Figure 3.4.1 has a county with either medium high (orange) or high (red) engagement in commercial fishing. These are counties that have a substantial amount of socio-economic activity devoted to commercial fishing and will likely have a number of communities with infrastructure to facilitate landing and processing of commercial catch, as well as docks for commercial vessels. Alabama and Mississippi are the only states that do not have a county that scores high or medium high for commercial fishing reliance. Florida's Panhandle and Louisiana's Delta region have several counties with high or medium high scores for reliance. For those counties with high reliance, the infrastructure described above will be present, but smaller populations of people are associated with it. This suggests that infrastructure may play a larger role in these counties' economy.

Figure 3.4.1. Commercial fishing engagement (left) and reliance (right) by county for 2014. The counties are coded as follows: dark green = low; light green = medium; orange = medium high; and red = high. Source: SERO ALS accessed in 2014.

Recreational Engagement and Reliance

Most Gulf states in Figure 3.4.2 have a county with either medium high or high engagement in recreational fishing, except Louisiana. Counties with medium high or high engagement have a substantial amount of socio-economic activity devoted to recreational fishing and will likely have a number of communities with infrastructure to facilitate landing recreational catch as well as boat ramps and docks for recreational vessels. Mississippi is the only state that does not have a county that scores high or medium high for recreational fishing reliance. Florida's Panhandle and west coast have several counties with high or medium high scores for both recreational engagement and reliance. For those counties with high reliance, that same infrastructure will exist, but smaller populations of people are associated with it, thus suggesting a larger role in the county economy.

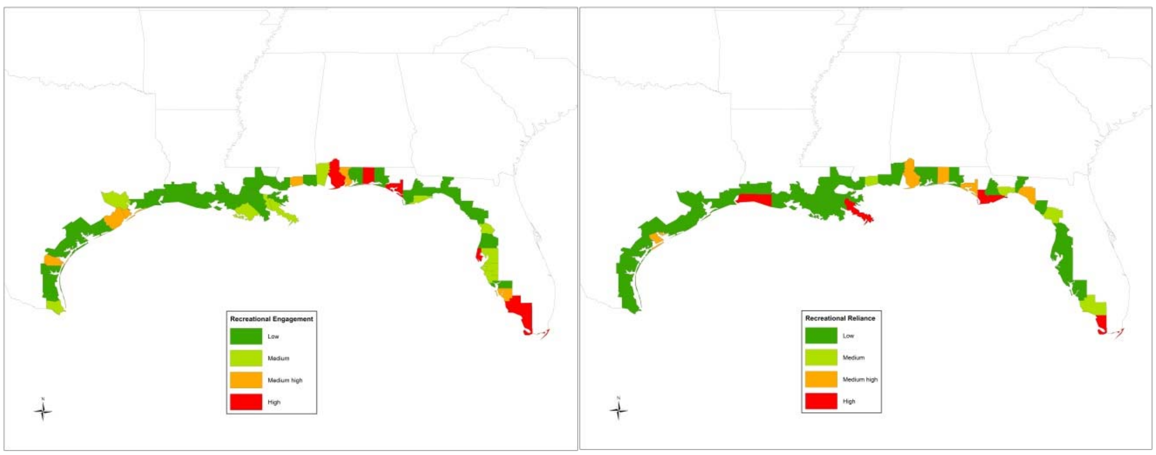

Figure 3.4.2. Recreational fishing engagement (left) and reliance (right) by county for 2014. The counties are coded as follows: dark green = low; light green = medium; orange = medium high; and red = high. Source: SERO ALS accessed in 2014.

3.4.2 Reef Fish Permits

Commercial

Figure 3.4.3 exhibits the distribution of commercial reef fish permits by community throughout the Gulf in 2014. The largest concentration of permits is along Florida's west coast and Panhandle. Louisiana has one community with greater than ten permits, while Texas has two. Alabama has two communities with more than 10 permits, while Mississippi has none.

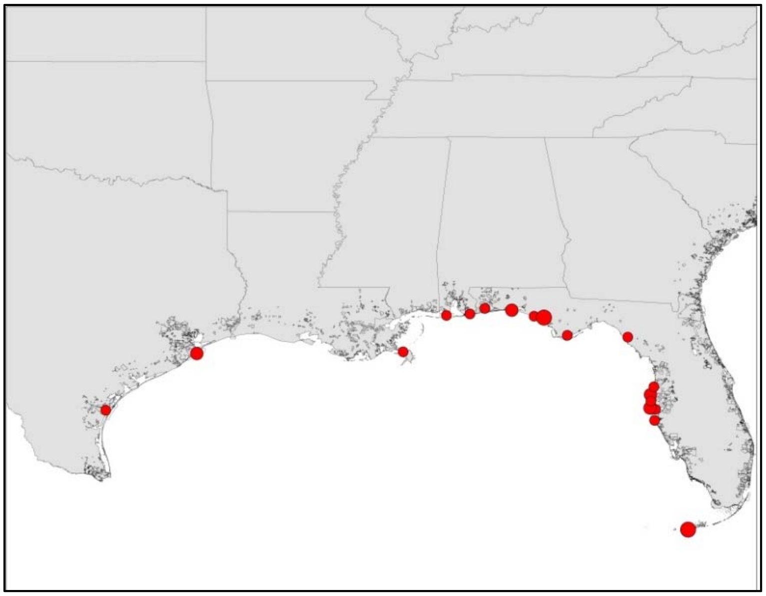

Figure 3.4.3. Communities with more than 10 commercial reef fish permits by vessel homeport. Source: SERO 2014.

Recreational

The distribution of reef fish charter vessel/headboat (for-hire) permits is provided in Figure 3.4.4. Similar to the distribution of commercial permits, the largest concentration of for-hire permits is along Florida's west coast and Panhandle area. However, there seems to be a greater concentration of for-hire permits along the western section of Florida's Panhandle and Baldwin County, Alabama, than is found for commercial permits. This would be expected as there are large fleets of for-hire vessels in Destin, Florida and Orange Beach, Alabama. Mississippi also has a community with more than 10 for-hire permits and Texas has 5 communities with more than 10 for-hire permits, each.

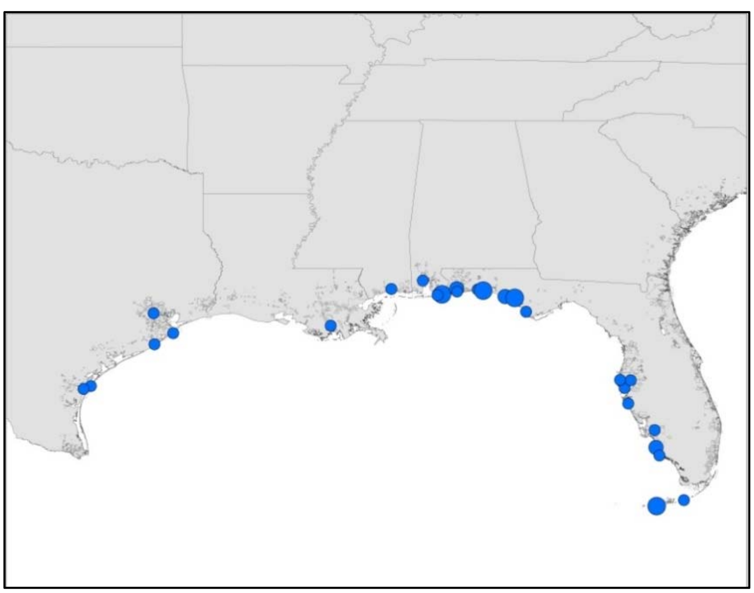

Figure 3.4.4. Communities with more than 10 reef fish for-hire permits by vessel homeport. Source: SERO 2014.

3.4.3 Environmental Justice

Executive Order 12898 requires federal agencies conduct their programs, policies, and activities in a manner to ensure individuals or populations are not excluded from participation in, or denied the benefits of, or subjected to discrimination because of their race, color, or national origin. In addition, and specifically with respect to subsistence consumption of fish and wildlife, federal agencies are required to collect, maintain, and analyze information on the consumption patterns of populations who principally rely on fish and/or wildlife for subsistence. The main focus of Executive Order 12898 is to consider "the disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories…" This executive order is generally referred to as environmental justice (EJ).

Because the action in this amendment establishes or modifies the thresholds for determining whether a reef fish species is overfished, this action would not be expected to affect any particular population, including those of EJ concern. Thus, it is unlikely that there are any EJ issues related to any potential indirect effects (see Section 4.1.4). For example, potential indirect effects could result from restrictive management measures put in place to rebuild a stock following an overfished determination due to exceeding the selected threshold (MSST). Nevertheless, any resulting management measures that would result from a rebuilding plan would not be applied disproportionately to any population and thus, no EJ issues are apparent at this time.

3.5 Description of the Administrative Environment

3.5.1 Federal Fishery Management

Federal fishery management is conducted under the authority of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) (16 U.S.C. 1801 *et seq*.), originally enacted in 1976 as the Fishery Conservation and Management Act. The Magnuson-Stevens Act claims sovereign rights and exclusive fishery management authority over most fishery resources within the exclusive economic zone, an area extending 200 nautical miles from the seaward boundary of each of the coastal states, and authority over U.S. anadromous species and continental shelf resources that occur beyond the exclusive economic zone.

Responsibility for federal fishery management is shared by the Secretary of Commerce (Secretary) and eight regional fishery management councils that represent the expertise and interests of constituent states. Regional councils are responsible for preparing, monitoring, and revising management plans for fisheries needing management within their jurisdiction. The Secretary is responsible for promulgating regulations to implement proposed plans and amendments after ensuring management measures are consistent with the Magnuson-Stevens Act and with other applicable laws summarized in Appendix A. In most cases, the Secretary has delegated this authority to NMFS.

The Council is responsible for fishery resources in federal waters of the Gulf. These waters extend to 200 nautical miles offshore from the seaward boundaries of the Gulf states of Alabama, Florida, Louisiana, Mississippi, and Texas, as those boundaries have been defined by law. The length of the Gulf coastline is approximately 1,631 miles. Florida has the longest coastline of 770 miles along its Gulf coast, followed by Louisiana (397 miles), Texas (361 miles), Alabama (53 miles), and Mississippi (44 miles).

The Council consists of seventeen voting members: 11 public members appointed by the Secretary; one each from the fishery agencies of Texas, Louisiana, Mississippi, Alabama, and Florida; and one from NMFS. The public is also involved in the fishery management process through participation on advisory panels and through Council meetings that, with few exceptions for discussing personnel matters, are open to the public. The regulatory process is also in accordance with the Administrative Procedures Act, in the form of "notice and comment" rulemaking, which provides extensive opportunity for public scrutiny and comment, and requires consideration of and response to those comments.

Regulations contained within FMPs are enforced through actions of the National Oceanic and Atmospheric Administration's Office of Law Enforcement, the United States Coast Guard, and various state authorities. To better coordinate enforcement activities, federal and state enforcement agencies have developed cooperative agreements to enforce the Magnuson-Stevens Act. These activities are being coordinated by the Council's Law Enforcement Advisory Panel and the Gulf States Marine Fisheries Commission's Law Enforcement Committee, which have developed joint enforcement agreements and cooperative enforcement programs (www.gsmfc.org).

Reef fish stocks are assessed through the Southeast Data Assessment and Review (SEDAR) process. As species are assessed, stock condition and acceptable biological catch (ABCs) are evaluated. As a result, periodic adjustments to stock ACLs and other management measures are deemed needed to prevent overfishing. Management measures are implemented through plan or regulatory amendments.

3.5.2 State Fishery Management

The purpose of state representation at the Council level is to ensure state participation in federal fishery management decision-making and to promote the development of compatible regulations in state and federal waters. The state governments of Texas, Louisiana, Mississippi, Alabama, and Florida have the authority to manage their respective state fisheries. Each of the five Gulf States exercises legislative and regulatory authority over their respective state's natural resources through discrete administrative units. Although each agency is the primary administrative body with respect to the states' natural resources, all states cooperate with numerous state and federal regulatory agencies when managing marine resources. A more detailed description of each state's primary regulatory agency for marine resources is provided on their respective Web pages (Table 3.5.2.1).

Table 3.5.2.1 Gulf of Mexico state marine resource agencies and Web pages.

State marine resource agency	Web page
Alabama Marine Resources Division	http://www.outdooralabama.com/
Florida Fish and Wildlife Conservation Commission	http://myfwc.com/
Louisiana Department of Wildlife and Fisheries	http://www.wlf.louisiana.gov/
Mississippi Department of Marine Resources	http://www.dmr.ms.gov/
Texas Parks and Wildlife Department	http://tpwd.texas.gov/

CHAPTER 4. ENVIRONMENTAL CONSEQUENCES

4.1 Action 1: Minimum Stock Size Threshold for Species in the Reef Fish Fishery Management Unit

4.1.1 Direct and Indirect Effects on the Physical Environment

Fishery management actions that affect the physical environment mostly relate to the interactions of fishing with bottom habitat, either through gear impacts to bottom habitat or through the incidental harvest of bottom habitat. The action does not affect the gear used and therefore has no direct impacts on the physical environment. However, changes to the minimum stock size threshold (MSST) could affect the likelihood of a stock being declared overfished, which could result in indirect effects. An "overfished" determination would require that a rebuilding plan be implemented, which would likely include restrictions that reduce fishing effort. Less fishing effort would result in less gear interaction with the physical habitat, which would be beneficial to the environment. Therefore, alternatives that allow overfishing to occur for a longer time (i.e., larger buffers between $B_{MSY\ (or\ proxy)}$ and MSST, would have a greater negative impact on the physical environment.

Alternative 1, no action, would leave MSST undefined except for the six stocks for which a definition currently exists. For these stocks (gag, red grouper, red snapper, vermilion snapper, gray triggerfish, and greater amberjack), the current MSST is the formula used in **Alternative 2** $(1-M)*B_{MSY\ (or\ proxy)}$. This is the most conservative approach considered for these six stocks, and results in the greatest likelihood of a stock being declared overfished, and therefore the greatest positive effect from reducing impacts to the physical environment. For hogfish, an MSST of $0.75*B_{MSY\ (or\ proxy)}$ has been being proposed in Amendment 43 separate from this action and would be implemented if approved. For the remaining stocks (and for hogfish if the Amendment 43 proposal is disapproved), MSST will continue to be undefined. Because of this lack of a threshold, impacts to the physical environment cannot be determined, but would likely be within the range of impacts for the remaining alternatives.

Alternative 2, which is the most conservative alternative except for stocks with natural mortality rates greater than 0.25 (gray triggerfish and greater amberjack), would likely have the greatest positive impact on the physical habitat by setting the MSST threshold at the most conservative level for all reef fish stocks. If this alternative were selected, the resulting hogfish MSST would be a more conservative 82.1% of $B_{MSY\ (or\ proxy)}$, rather than the less conservative 75% of $B_{MSY\ (or\ proxy)}$ proposed in Amendment 43.

Alternative 3 would use the same formula as **Alternative 2** ($(1-M)*B_{MSY\ (or\ proxy)}$) for stocks with a natural mortality rate higher than M = 0.25, and would set MSST at 75% of the $B_{MSY\ (or\ proxy)}$ for all other stocks. Stocks that have a current or proposed MSST definition would be affected as follows:

- The MSST level of 75% of the $B_{MSY\ (or\ proxy)}$ is proposed for hogfish in Amendment 43 and would remain at that level under this alternative.

- Vermilion snapper currently has MSST defined as $(1-M)*B_{MSY\ (or\ proxy)}$, but it has a natural mortality rate of M = 0.25. Therefore, its MSST is currently 75% of the $B_{MSY\ (or\ proxy)}$ and it would remain at that level.
- Three reef fish stocks currently have MSST defined as $(1-M)*B_{MSY\ (or\ proxy)}$, and have a natural mortality rate less than M = 0.25 (gag, red grouper, red snapper). For these stocks, MSST is currently narrower than 75% of $B_{MSY\ (or\ proxy)}$ (85%, 80%, and 91% respectively). For these three stocks, the MSST buffer would become wider at 75% $B_{MSY\ (or\ proxy)}$.
- Gray triggerfish and greater amberjack have natural mortality rates greater than M = 0.25, and would therefore continue to use the $(1-M)*B_{MSY}$ formula. The xisting MSST levels for these stocks are 73% and 72% of $B_{MSY\ (or\ proxy)}$, respectively.

For stocks other than gray triggerfish and greater amberjack, this would reduce the likelihood of a stock being declared overfished, and would therefore be expected have a greater negative impact to the physical environment relative to **Alternative 2**. For gray triggerfish and greater amberjack the existing MSST definition would be unchanged and would result in a wider (and therefore less conservative) MSST buffer. However, the buffer between B_{MSY} and MSST would be only slightly wider than if the 75% buffer were used and therefore the relative negative impact would be only slightly greater.

Alternative 4 is similar to **Alternative 3** except that it would apply to 75% * $B_{MSY\ (or\ proxy)}$ formula to all reef fish stocks including gray triggerfish and greater amberjack. For gray triggerfish and greater amberjack, the 75% * $B_{MSY\ (or\ proxy)}$ formula is slightly more conservative that $(1-M)*B_{MSY\ (or\ proxy)}$ (which would result in MSST of 73% and 72% of $B_{MSY\ (or\ proxy)}$ respectively). This alternative would be expected to have negative impacts relative to **Alternative 2**, but slight less negative impact than **Alternative 3** because the buffer between B_{MSY} and MSST for gray triggerfish and greater amberjack would be wider under **Alternative 3**.

Alternative 5 would set MSST at 50% * B_{MSY}, which is the lowest MSST allowed under the National Standard 1 guidelines. Relative to the other alternatives, this would result in the lowest likelihood of a stock being declared overfished, and would therefore be expected have a greatest negative impact to the physical environment.

4.1.2 Direct and Indirect Effects on the Biological Environment

MSST determines how low a declining stock can drop before it is declared overfished and in need on a rebuilding plan. The lower MSST is set, the longer it will take to rebuild the stock, or the more restrictive the management measures will need to be to rebuild the stock within a given time period. Any rebuilding plan will have overall positive impacts on the affected species by restoring it to a healthy biomass level, but lower MSST thresholds that allow a stock to experience greater declines and result in a longer or more restrictive rebuilding plan will have greater negative impacts within the plan from increased discards of the overfished stock, and possible effort shifting to other species.

Effort shifting to alternative species would likely be to other reef fish species that occur in the same general habitat. When the seasons for these alternative species are open and the fish caught are of legal size and recreational bag limits or commercial trip limit and individual quota limits (where applicable), they will usually be retained. However, if released due to catch limits, seasons, or other regulatory measures, these fish are considered bycatch. Bycatch practicability analyses have been completed for red snapper (GMFMC 2004c, GMFMC 2007, GMFMC 2014, GMFMC 2015d), grouper (GMFMC 2008c, GMFMC 2009, GMFMC 2011a, GMFMC 2012d), vermilion snapper (GMFMC 2004c), greater amberjack (GMFMC 2008b, GMFMC 2012a), gray triggerfish (GMFMC 2012b), and hogfish (GMFMC 2016). In general, these analyses have found that reducing bycatch provides biological benefits to managed species as well as benefits to the fishery through less waste, higher yields, and less forgone yield. In some cases, actions are approved that can increase bycatch through regulatory discards such as increased minimum sizes and closed seasons. Under these circumstances, biological benefit to the managed species outweighs any increases in discards from the action.

Alternative 1, no action, would leave MSST undefined except for the seven stocks for which a definition currently exists or as been proposed. For six of these stocks (gag, red grouper, red snapper, vermilion snapper, gray triggerfish, and greater amberjack), the current MSST is the formula used in **Alternative 2** ($(1-M)*B_{MSY\ (or\ proxy)}$). This is the most conservative approach considered for these six stocks, and provides the greatest positive benefits by minimizing the time needed to rebuild the stock and minimizing effort shifting and the accompanying discards of other species. For the seventh stock (hogfish) an MSST of 75% of $B_{MSY\ (or\ proxy)}$ has been proposed in Amendment 43 separate from this action. Although this is less conservative than the $(1-M)*B_{MSY\ (or\ proxy)}$ formula for hogfish, have some definition of MSST provides more benefits than leaving MSST undefined.

+ For the remaining stocks, MSST will continue to be undefined. Because of this lack of a threshold, impacts to the biological/environment environment cannot be determined, but would likely be within the range of impacts for the remaining alternatives.

Alternative 2, which is the most conservative alternative except for stocks that have a natural mortality rate greater than M = 0.25 (gray triggerfish and greater amberjack), would have the greatest positive impact on the biological/ecological habitat by setting the MSST threshold at the most conservative level for all reef fish stocks except hogfish. This would minimize the time needed to rebuild the stock and would minimize effort shifting and the accompanying discards of other species.

Alternative 3 would use the same formula as **Alternative 2** ($(1-M)*B_{MSY\ (or\ proxy)}$) for stocks with a natural mortality rate higher than M = 0.25, and would set MSST at 75% of the $B_{MSY\ (or\ proxy)}$ proxy for all other stocks. The MSST level of 75% of the $B_{MSY\ (or\ proxy)}$ is proposed for hogfish in Amendment 43. It would be applied to all reef fish species except gray triggerfish and greater amberjack, both of which have natural mortality rates greater than M = 0.25, and would therefore continue to use the ($(1-M)*B_{MSY\ (or\ proxy)}$) formula. For stocks that drop below this threshold and are declared overfished, this would result in a longer rebuilding time or more restrictive management measures than **Alternative 2** (except gray triggerfish and greater amberjack) or the six species in **Alternative 1** with MSST defined as $(1-M)*B_{MSY\ (or\ proxy)}$, and therefore greater negative impacts to the biological/ecological environment would be expected. For gray triggerfish and greater amberjack, this would produce a slightly less conservative threshold (i.e., $B_{MSY\ (or\ proxy)}$) could drop to a lower level before an overfished condition is declared) than the current MSST definition (73% for gray triggerfish and 72% for greater amberjack instead of 75% of $B_{MSY\ (or\ proxy)}$). However, these stocks are currently overfished and under rebuilding plans which would not be affected by the new MSST definition.

Alternative 4 would set MSST at 75% of the $B_{MSY\ (or\ proxy)}$ for all reef fish stocks including gray triggerfish and greater amberjack. This is also the proposed MSST definition for hogfish in Amendment 43. It is nearly identical to **Alternative 3** except that it would provide a slightly more conservative MSST buffer (i.e., MSST would be slightly closer to $B_{MSY\ (or\ proxy)}$) than **Alternative 1**, **Alternative 2**, or **Alternative 3** for gray triggerfish and greater amberjack. Gray triggerfish and greater amberjack are currently under rebuilding plans which would not be affected by the new MSST definition. However, once rebuilt, any subsequent decline in biomass would result in an overfished determination at a slightly higher biomass level than either **Alternative 1**, **Alternative 2**, or **Alternative 3**.

Alternative 5 would set MSST at 50% * $B_{MSY(or\ proxy)}$, which is the lowest MSST allowed under the National Standard 1 guidelines. Relative to the other alternatives, this would result in the longest rebuilding time and the most restrictive management measures, and would therefore have the greatest negative impacts on the biological/ecological environment. Red snapper and greater amberjack are both below this threshold (red snapper = 37% of B_{MSY} from SEDAR 31 2013, greater amberjack = 47% of B_{MSY} from SEDAR 33 2014), and would therefore continue to be classified as overfished and under a rebuilding plan. Gray triggerfish is currently at 54% of B_{MSY} and is therefore above 50% * B_{MSY} based on the SEDAR 43 assessment (SEDAR 43 2015). Gray triggerfish would be reclassified from overfished to rebuilding, but would remain under a rebuilding plan until it reaches the B_{MSY} stock level.

4.1.3 Direct and Indirect Effects on the Economic Environment

This action considers modifications to existing MSST for reef fish species with previously defined MSST and the establishment of MSST values for stocks that do not have a specified MSST. **Alternative 1** (no action) would maintain the previously specified MSSTs and would leave MSST undefined for reef fish species that do not have a defined MSST value. Therefore, **Alternative 1** would not be expected to alter the harvest of reef fish species and would not be expected to result in direct economic effects. However, **Alternative 1** may result in adverse indirect economic effects if the absence of a specified MSST leads to a failure to implement corrective measures for an overfished species. The magnitude of indirect adverse economic effects would be determined by the negative biological effects on the stocks that would result from the failure to recognize the overfished status.

Alternatives 2-5 consider MSST values ranging from 0.50*B_{MSY} (**Alternative 5**) to (1-M)*B_{MSY} (**Alternative 2** when M is less than 0.25). The establishment of MSST values is an administrative action and would therefore not be expected to result in direct economic effects.

Alternative 5 would set the lowest MSST values and would be associated with the smallest likelihood of classifying a reef fish stock as overfished. **Alternative 5** would afford more flexibility to manage the stocks by providing a wider buffer between MSST and the biomass at maximum sustainable yield (MSY). Therefore, **Alternative 5** would be expected to result in indirect positive economic effects stemming from additional harvesting opportunities made available due to the increased management flexibility. The magnitude of the potential indirect economic benefits would be determined by the additional harvests afforded to commercial fishermen and recreational anglers. However, should a particular stock be declared overfished, a smaller MSST would be expected to require more restrictive rebuilding measures, thereby resulting in negative indirect economic effects during the rebuilding period. Although unknown at this time, the net effects that would be expected from MSST adjustments would depend on the relative size of these benefits and adverse economic effects.

Because **Alternative 4** would set a greater MSST than **Alternative 5**, it is expected that potential benefits due to management flexibility would be lessened under **Alternative 4**. However, compared to **Alternative 5**, **Alternative 4** would warrant less restrictive rebuilding measures if the stock is overfished, thereby resulting in smaller negative effects during the rebuilding period.

For all reef fish stocks (except gray triggerfish and greater amberjack which set MSST at 73% and 72% of the B_{MSY}), **Alternative 3** would set MSST at the same level as **Alternative 4** ($0.75*B_{MSY}$). Therefore, economic effects expected to result from **Alternatives 3** and **4** would be comparable.

Because the estimated natural mortality for most reef fish species is below 0.25 (except vermilion snapper, greater amberjack, and gray triggerfish with M of 0.25, 0.28, and 0.27, respectively), compared to **Alternatives 3-5**, **Alternative 2** would set higher MSST values. Therefore, **Alternative 2** is expected to result in the lowest potential economic benefits due to the buffer between the MSST and the biomass at MSY. Conversely, **Alternative 2** would also be expected to result in the least restrictive rebuilding measures should a stock be declared overfished. Therefore, **Alternative 2** is expected to result in the smallest indirect adverse economic effects during rebuilding.

4.1.4 Direct and Indirect Effects on the Social Environment

This action sets or modifies MSST, the threshold at which a stock would be considered overfished, for reef fish species. Direct effects would not be expected from setting or modifying the overfished threshold. Rather, indirect effects would be tied to future determinations of whether the stock is overfished. The closer the threshold is set to MSY, the more likely for the overfished threshold to be triggered, resulting in negative effects from the loss of harvest opportunities. On the other hand, the farther away the threshold is set from MSY, the less likely the overfished threshold would be triggered. However, the rebuilding plan under this scenario would likely require more restrictive measures, resulting in greater negative social effects, than if the threshold had been triggered sooner.

The management measures for a rebuilding plan that may follow a stock's determination as overfished as a result of setting or modifying the MSST are unknown. Thus, it is not possible to describe the scope and strength of any indirect effects from triggering an overfished status.

Therefore, this discussion of social effects is general and qualitative in nature. Further, if the overfished thresholds are not changed for some species, they may move into an overfished status due to natural fluctuations large enough to trigger a threshold that is too close to MSY. This would require the initiation of action due to the overfished status that could have negative social effects if harvest levels are reduced significantly with little notice.

Alternative 1 would not change the definition of MSST and there would be no change in the management of stocks. For most of those stocks where MSST has been defined, the narrowest and most conservative buffer has been used. Therefore, some stocks may still be susceptible to moving in and out of an overfished status due to natural fluctuations in biomass. Furthermore, the MSST would remain undefined for most reef fish stocks, leaving no way to determine overfished status. That uncertainty can have negative impacts on business planning and other aspects of both commercial and recreational fishing, as it may initiate changes in fishing behavior such as switching to other species or increased regulatory discards.

Alternative 2 would use a MSST that provides a narrow buffer, particularly for stocks with a low natural mortality rate (e.g., less than M = 0.25). These stocks may be susceptible to moving in and out of an overfished status due to natural fluctuations in biomass. Furthermore, given the lack of precision in the estimates of B_{MSY}, MSST, and current biomass, particularly for data-limited stocks, there is increased uncertainty with respect to whether the current biomass has actually dropped below MSST. The more stable approach to setting a wider buffer that prevents a stock from moving into an overfished status is preferable as a more stable fishery is better for both commercial and recreational stakeholders and businesses.

Alternative 3 would set a buffer that sets MSST at 75% of B_{MSY} unless use of the **Alternative 2** formula would result in an even wider buffer. Only two stocks for which the natural mortality rate has been estimated would result in a wider buffer (gray triggerfish and greater amberjack). For those two stocks the MSST buffer would be equal to **Alternative 2**, and for all other reef fish stocks the resulting MSST buffer would be wider than under **Alternative 2**.

Alternative 4 is similar to **Alternative 3** except that it applies the 75% buffer to all stocks, including gray triggerfish and greater amberjack, which would receive slightly narrower MSST buffers than under **Alternative 3**.

Alternative 5 would adopt the widest buffer allowed under the NS 1 guidelines, and would increase the buffer for all stocks where currently defined. As shown in Table 2.1.1, this MSST definition would result in one stock (gray triggerfish) being redefined from overfished to not overfished. However, because the stock is currently below its B_{MSY} level, rebuilding would continue to be required.

Any stock that is currently in a rebuilding plan as a result of having dropped below the status quo MSST will continue the requirement to rebuild to B_{MSY} even if a new definition of MSST places it above MSST (but below B_{MSY}). Therefore, there would be no change in current social effects from the status quo. For all other stocks, the social effects from any alternative would be indirect and long term, occurring once a determination of overfished status has been made based on the selected buffer. Wider buffers may allow for current fishing activity to continue, but risk future fishing activity being curtailed if the stock falls into an overfished status. Narrow buffers may be more likely to result in an overfished determination and the subsequent rebuilding plan could curtail existing fishing effort, but may allow for more stable fishing activity over the long term.

4.1.5 Direct and Indirect Effects on the Administrative Environment

This action will directly affect the administrative environment. Currently, there are several reef fish species that do not have defined overfished thresholds. The proposed action would establish overfished thresholds (MSST) for all federally managed Gulf of Mexico (Gulf) reef fish stocks, consistent with the requirements of the Magnuson-Stevens Act Fishery Conservation and Management Act (Magnuson-Stevens Act), which requires that overfished thresholds (MSST) be developed for all stocks under management. Under **Alternatives 2-5**, MSST would be defined for all reef fish species through one action. Thus, selecting any of these alternatives as preferred would be administratively more efficient than approving a species' MSST through multiple future actions as each species is assessed. This less efficient approach would occur under **Alternative 1**, which would be more adverse to the administrative environment.

How MSST is determined under **Alternatives 2-5** also has indirect administrative implications. The lower the MSST value is (i.e., the greater the difference between B_{MSY} (or proxy) and MSST), the less likely a stock could be depressed below the MSST and be declared overfished. However, after a stock has been declared overfished, action must be taken to rebuild the stock to B_{MSY} (or proxy). The greater the difference between the overfished stock biomass and B_{MSY} (or proxy), the greater the harvest restrictions would need to be to allow the stock to recover to B_{MSY} (or proxy) within the rebuilding timeframe. Therefore, the lower MSST is, the greater the likelihood any rebuilding plan would require more restrictive management measures.

How the alternatives compare to one another is dependent on M and how it influences the calculation of MSST. If M is less than or equal to 0.25, then the MSST from **Alternative 3** is equivalent to the MSST in **Alternative 4** because both would be equal to $0.75*B_{MSY}$. However, if M is greater than 0.25, then the MSST from **Alternative 2** is equivalent to the MSST from **Alternative 3** because both would be equal to $(1-M)*B_{MSY}$. This is illustrated in Table 4.1.5.1, which calculates MSST for each alternative using a hypothetical B_{MSY} of one million pounds and two values for M (0.2 and 0.3) that are either above or below 0.25. Under this example, if M is set at 0.20 (≤ 0.25), then the probability of the stock being declared overfished is greatest for **Alternative 2** (800,000 lbs) and least for **Alternative 5** (500,000 lbs). **Alternatives 3 and 4** are equal (750,000 lbs) and would be intermediate to **Alternatives 2 and 5**. If M is set at 0.30 (greater than 0.25), then the probability of being declared overfished would be greatest for **Alternative 4** (750,000 lbs) and least for **Alternative 5** (500,000 lbs). The probability for **Alternatives 2 and 3** would be equal (700,000 lbs) and intermediate to **Alternatives 4 and 5**.

Table 4.1.5.1. The estimated minimum stock size threshold values in pounds under two natural mortality rates (M) if the stock biomass that would provide the maximum sustainable yield is assumed to be 1,000,000 lbs.

	Alternative 2	Alternative 3	Alternative 4	Alternative 5

Natural Mortality	$(1-M)*B_{MSY}$	$(1-M)*B_{MSY}$ or $0.75*B_{MSY}$	$0.75*B_{MSY}$	$0.5*B_{MSY}$
M = 0.20	800,000 lbs	750,000 lbs	750,000 lbs	500,000 lbs
M = 0.30	700,000 lbs	700,000 lbs	750,000 lbs	500,000 lbs

Conversely, the probability of needing greater harvest restrictions to rebuild the stock should the stock size fall below MSST is also dependent on what M is as discussed above. Under the example shown in Table 4.1.5.1, if M is 0.20 (less than or equal to 0.25), then the probability of greater harvest restrictions to rebuild the stock is greatest for **Alternative 5** (500,00m lbs) and least for **Alternative 2** (800,000 lbs). **Alternatives 3 and 4** are equal (750,000 lbs) and would be intermediate to **Alternatives 2 and 5**. If M is 0.30 (greater than 0.25), then the probability of greater harvest restrictions to rebuild the stock would still be greatest for **Alternative 5** (500,000 lbs) but least for **Alternative 4** (750,000 lbs). The probability for **Alternatives 2 and 3** would be equal (700,000 lbs) and be intermediate to **Alternatives 4 and 5**.

Although the alternatives have different effects on the administrative environment, these effects are likely minor. Assessing stocks to determine if the stock biomass is above or below MSST are routine endeavors by National Marine Fishery Service (NMFS). Actions to control harvest by the Council and NMFS are mostly routine and conducted through the Gulf of Mexico Fishery Management Council (Council) system established by the Magnuson-Stevens Act. Additionally, through the use of annual catch limits (ACLs) and accountability measures, the Council and NMFS can determine if overfishing is occurring annually and take measures to reduce the likelihood a stock would get into an overfished condition. This minimizes the risk that the stock size would fall below MSST and be considered overfished.

4.2 Cumulative Effects Analysis

The cumulative effects from managing the reef fish fishery have been analyzed in Amendments 30A (GMFMC 2008c), 30B (GMFMC 2008b), 31 (GMFMC 2009), 32 (GMFMC 2011b), 40 (GMFMC 2014), and 28 (GMFMC 2015) and are incorporated here by reference. Additional pertinent past actions are summarized in the history of management (Section 1.3). Currently, there are eight reasonably foreseeable future actions (RFFAs) that are being considered by the Council, which could affect reef fish stocks. These are: a framework action to modify to mutton snapper and gag management measures; Amendment 36A, which would modify the commercial individual fish quota (IFQ) program; Amendments 41 and 42, which would address management of the charter vessel and headboat components of the reef fish fishery; Amendment 46, which would modify the current gray triggerfish rebuilding plan; Amendment 47, which would modify vermilion snapper ACLs and maximum sustainable yield (MSY) proxies; and a generic amendment to require electronic reporting for charter vessels to improve the quality and timeliness of landings data for this component of the recreational sector.

The affected area of this proposed action encompasses the state and federal waters of the Gulf of Mexico (Gulf) as well as Gulf communities that are dependent on reef fish fishing. The proposed action would define the overfished threshold for reef fish species. This action combined with past and RFFAs is not expected to have significant beneficial or adverse effects on the physical and biological/ecological environments because this action will only minimally affect current fishing practices (see Sections 4.1.1 and 4.1.2). However, for the social and economic environments, short-term adverse effects are likely (see Sections 4.1.3, and 4.1.4) and could result in economic losses to fishing communities. These short-term effects are expected to be compensated for by long-term management goals to maintain the stock at healthy levels. This action, combined with past and RFFAs is not expected to have significant adverse effects on public health or safety. The proposed action (see Sections 4.1.1 and 4.1.2), along with past and RFFAs, are not expected to substantially alter the manner in which the fishery is prosecuted.

Non-Fishery Management Plan (FMP) actions affecting the reef fish fishery have been described in previous cumulative effect analyses (e.g., Amendment 40). Three important events include impacts of the Deepwater Horizon MC252 oil spill, the Northern Gulf Hypoxic Zone, and climate change. Reef fish species are mobile and are able to avoid hypoxic conditions, so any effects from the Northern Gulf Hypoxic Zone on reef fish species are likely minimal regardless of this action. Impacts from the Deepwater Horizon MC252 oil spill are still being examined; however, as indicated in Section 3.2, the oil spill had some adverse effects on fish species. However, it is unlikely that the oil spill in conjunction with setting MSST values would have any significant cumulative effect given the primarily administrative function of this action.

There is a large and growing body of literature on past, present, and future impacts of global climate change induced by human activities. Some of the likely effects commonly mentioned are sea level rise, increased frequency of severe weather events, and change in air and water temperatures. The Environmental Protection Agency's (EPA) climate change web page provides basic background information on these and other measured or anticipated effects. In addition, the Intergovernmental Panel on Climate Change (IPCC) has numerous reports addressing their assessments of climate change (http://www.ipcc.ch/publications_and_data/publications_and_data.shtml). Global climate changes could affect the Gulf fisheries as discussed in Section 3.3. However, the extent of these effects cannot be quantified at this time. The proposed action is not expected to significantly contribute to climate change through the increase or decrease in the carbon footprint from fishing as these actions should not change how the fishery is prosecuted. As described in Section 3.3, the contribution to greenhouse gas emissions from fishing is minor compared to other emission sources (e.g., oil platforms).

The effects of the proposed action are, and will continue to be, monitored through collection of landings data by NMFS, stock assessments and stock assessment updates, life history studies, economic and social analyses, and other scientific observations. Landings data for the recreational sector in the Gulf are collected through Marine Recreational Information Program (MRIP), the Southeast Region Headboat Survey (SRHS), and the Texas Marine Recreational Fishing Survey. In addition, the Louisiana Department of Wildlife and Fisheries and the Alabama Department of Conservation and Natural Resources have instituted programs to collect information on reef fish, and in particular, red snapper recreational landings information in their respective states. Commercial data are collected through trip ticket programs, port samplers, and logbook programs, as well as dealer reporting through the individual fishing quota program.

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GMFMC = Gulf of Mexico Fishery Management Council; NOAA GC = National Oceanic and Atmospheric Administration General Counsel; SEFSC = Southeast Fisheries Science Center; SERO = Southeast Regional Office of the National Marine Fisheries Service

CHAPTER 6. LIST OF AGENCIES CONSULTED

National Marine Fisheries Service
- Southeast Fisheries Science Center
- Southeast Regional Office
- Office for Law Enforcement

National Oceanic Atmospheric Administration General Counsel

Environmental Protection Agency
United States Coast Guard
United States Fish and Wildlife Services
Texas Parks and Wildlife Department
Alabama Department of Conservation and Natural Resources/Marine Resources Division
Louisiana Department of Wildlife and Fisheries
Mississippi Department of Marine Resources
Florida Fish and Wildlife Conservation Commission

CHAPTER 7. REFERENCES

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APPENDIX A – OTHER APPLICABLE LAW

(16 U.S.C. 1801 et seq.) provides the authority for fishery management in federal waters of the exclusive economic zone. However, fishery management decision-making is also affected by a number of other federal statutes designed to protect the biological and human components of U.S. fisheries, as well as the ecosystems that support those fisheries. Major laws affecting federal fishery management decision-making are summarized below.

Administrative Procedure Act

All federal rulemaking is governed under the provisions of the Administrative Procedure Act (APA) (5 U.S.C. 551 et seq.), which establishes a "notice and comment" procedure to enable public participation in the rulemaking process. Under the APA, the National Marine Fisheries Service (NMFS) is required to publish notification of proposed rules in the *Federal Register* and to solicit, consider, and respond to public comment on those rules before they are finalized. The APA also establishes a 30-day waiting period from the time a final rule is published until it takes effect.

Coastal Zone Management Act

Section 307(c)(1) of the federal Coastal Zone Management Act of 1972 (CZMA), as amended, requires that federal activities that affect any land or water use or natural resource of a state's coastal zone be conducted in a manner consistent, to the maximum extent practicable, with approved state coastal management programs. The requirements for such a consistency determination are set forth in NMFS regulations at 15 C.F.R. part 930, subpart C. According to these regulations and CZMA Section 307(c)(1), when taking an action that affects any land or water use or natural resource of a state's coastal zone, NMFS is required to provide a consistency determination to the relevant state agency at least 90 days before taking final action.

Upon submission to the Secretary, NMFS will determine if this plan amendment is consistent with the Coastal Zone Management programs of the states of Alabama, Florida, Louisiana, Mississippi, and Texas to the maximum extent possible. NMFS's determination will then be submitted to the responsible state agencies under Section 307 of the CZMA administering approved Coastal Zone Management programs for these states.

Data Quality Act

The Data Quality Act (DQA) (Public Law 106-443), effective October 1, 2002, requires the government to set standards for the quality of scientific information and statistics used and disseminated by federal agencies. Information includes any communication or representation of knowledge such as facts or data, in any medium or form, including textual, numerical, cartographic, narrative, or audiovisual forms (includes web dissemination, but not hyperlinks to information that others disseminate; does not include clearly stated opinions).

Specifically, the DQA directs the Office of Management and Budget to issue government-wide guidelines that "provide policy and procedural guidance to federal agencies for ensuring and maximizing the quality, objectivity, utility, and integrity of information disseminated by federal agencies." Such guidelines have been issued, directing all federal agencies to create and disseminate agency-specific standards to: 1) ensure information quality and develop a pre-dissemination review process; 2) establish administrative mechanisms allowing affected persons to seek and obtain correction of information; and 3) report periodically to Office of Management and Budget on the number and nature of complaints received.

Scientific information and data are key components of fishery management plans (FMPs) and amendments and the use of best available information is the second national standard under the Magnuson-Stevens Act. To be consistent with the DQA, FMPs and amendments must be based on the best information available. They should also properly reference all supporting materials and data, and be reviewed by technically competent individuals. With respect to original data generated for FMPs and amendments, it is important to ensure that the data are collected according to documented procedures or in a manner that reflects standard practices accepted by the relevant scientific and technical communities. Data will also undergo quality control prior to being used by the agency and a pre-dissemination review.

Endangered Species Act

The Endangered Species Act (ESA) of 1973, as amended, (16 U.S.C. Section 1531 et seq.) requires federal agencies to use their authorities to conserve endangered and threatened species. The ESA requires NMFS, when proposing a fishery action that "may affect" critical habitat or endangered or threatened species, to consult with the appropriate administrative agency (itself for most marine species, the U.S. Fish and Wildlife Service for all remaining species) to determine the potential impacts of the proposed action. Consultations are concluded informally when proposed actions may affect but are "not likely to adversely affect" endangered or threatened species or designated critical habitat. Formal consultations, including a biological opinion, are required when proposed actions may affect and are "likely to adversely affect" endangered or threatened species or adversely modify designated critical habitat. If jeopardy or adverse modification is found, the consulting agency is required to suggest reasonable and prudent alternatives. A summary of the most recent biological opinion is provided in Section 3.2 of Amendment 44.

Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) established a moratorium, with certain exceptions, on the taking of marine mammals in U.S. waters and by U.S. citizens on the high seas, and on the importing of marine mammals and marine mammal products into the United States. Under the MMPA, the Secretary of Commerce (authority delegated to NMFS) is responsible for the conservation and management of cetaceans and pinnipeds (other than walruses). The Secretary of the Interior is responsible for walruses, sea and marine otters, polar bears, manatees, and dugongs.

Part of the responsibility that NMFS has under the MMPA involves monitoring populations of marine mammals to make sure that they stay at optimum levels. If a population falls below its optimum level, it is designated as "depleted," and a conservation plan is developed to guide research and management actions to restore the population to healthy levels.

In 1994, Congress amended the MMPA to govern the taking of marine mammals incidental to commercial fishing operations. This amendment required the preparation of stock assessments for all marine mammal stocks in waters under U.S. jurisdiction, development and implementation of take-reduction plans for stocks that may be reduced or are being maintained below their optimum sustainable population levels due to interactions with commercial fisheries, and studies of pinniped-fishery interactions.

Under Section 118 of the MMPA, NMFS must publish, at least annually, a List of Fisheries that places all U.S. commercial fisheries into one of three categories based on the level of incidental serious injury and mortality of marine mammals that occurs in each fishery. The categorization of a fishery in the List of Fisheries determines whether participants in that fishery may be required to comply with certain provisions of the MMPA, such as registration, observer coverage, and take reduction plan requirements. The conclusions of the most recent List of Fisheries for gear used by the reef fish fishery can be found in Section 3.2 of Amendment 44.

Paperwork Reduction Act

The Paperwork Reduction Act of 1995 (PRA) (44 U.S.C. 3501 et seq.) regulates the collection of public information by federal agencies to ensure the public is not overburdened with information requests, the federal government's information collection procedures are efficient, and federal agencies adhere to appropriate rules governing the confidentiality of such information. The PRA requires NMFS to obtain approval from the Office of Management and Budget before requesting most types of fishery information from the public. Setting reef fish minimum stock size thresholds would not have PRA consequences.

Executive Orders

E.O. 12630: Takings

The Executive Order on Government Actions and Interference with Constitutionally Protected Property Rights that became effective March 18, 1988, requires each federal agency to prepare a Takings Implication Assessment for any of its administrative, regulatory, and legislative policies and actions that affect, or may affect, the use of any real or personal property. Clearance of a regulatory action must include a takings statement and, if appropriate, a Takings Implication Assessment. The National Oceanic and Atmospheric Administration Office of General Counsel will determine whether a Taking Implication Assessment is necessary for this amendment.

E.O. 12866: Regulatory Planning and Review

Executive Order 12866: Regulatory Planning and Review, signed in 1993, requires federal agencies to assess the costs and benefits of their proposed regulations, including distributional impacts, and to select alternatives that maximize net benefits to society. To comply with E.O. 12866, NMFS prepares a Regulatory Impact Review (RIR) for all fishery regulatory actions that either implement a new fishery management plan or significantly amend an existing plan (See Chapter 5). RIRs provide a comprehensive analysis of the costs and benefits to society of proposed regulatory actions, the problems and policy objectives prompting the regulatory proposals, and the major alternatives that could be used to solve the problems. The reviews also serve as the basis for the agency's determinations as to whether proposed regulations are a "significant regulatory action" under the criteria provided in E.O. 12866 and whether proposed regulations will have a significant economic impact on a substantial number of small entities in compliance with the Regulatory Flexibility Analysis. A regulation is significant if it a) has an annual effect on the economy of $100 million or more or adversely affects in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments and communities; b) creates a serious inconsistency or otherwise interferes with an action taken or planned by another agency; c) materially alters the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or d) raises novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in this Executive Order.

E.O. 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations

This Executive Order mandates that each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions. The Executive Order is described in more detail relative to fisheries actions in Section 3.4.2.

E.O. 12962: Recreational Fisheries

This Executive Order requires federal agencies, in cooperation with states and tribes, to improve the quantity, function, sustainable productivity, and distribution of U.S. aquatic resources for increased recreational fishing opportunities through a variety of methods including, but not limited to, developing joint partnerships; promoting the restoration of recreational fishing areas that are limited by water quality and habitat degradation; fostering sound aquatic conservation and restoration endeavors; and evaluating the effects of federally-funded, permitted, or authorized actions on aquatic systems and recreational fisheries, and documenting those effects. Additionally, it establishes a seven-member National Recreational Fisheries Coordination Council (Council) responsible for, among other things, ensuring that social and economic values of healthy aquatic systems that support recreational fisheries are considered by federal agencies in the course of their actions, sharing the latest resource information and management technologies, and reducing duplicative and cost-inefficient programs among federal agencies involved in conserving or managing recreational fisheries. The Council also is responsible for developing, in cooperation with federal agencies, States and Tribes, a Recreational Fishery Resource Conservation Plan - to include a five-year agenda. Finally, the Order requires NMFS and the U.S. Fish and Wildlife Service to develop a joint agency policy for administering the ESA.

E.O. 13132: Federalism

The Executive Order on Federalism requires agencies in formulating and implementing policies, to be guided by the fundamental Federalism principles. The Order serves to guarantee the division of governmental responsibilities between the national government and the states that was intended by the framers of the Constitution. Federalism is rooted in the belief that issues not national in scope or significance are most appropriately addressed by the level of government closest to the people. This Order is relevant to FMPs and amendments given the overlapping authorities of NMFS, the states, and local authorities in managing coastal resources, including fisheries, and the need for a clear definition of responsibilities. It is important to recognize those components of the ecosystem over which fishery managers have no direct control and to develop strategies to address them in conjunction with appropriate state, tribes, and local entities (international, too).

E.O. 13158: Marine Protected Areas

This Executive Order requires federal agencies to consider whether their proposed action(s) will affect any area of the marine environment that has been reserved by federal, state, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural or cultural resource within the protected area. There are several marine protected areas, habitat areas of particular concern, and gear-restricted areas in the eastern and northwestern Gulf.

Essential Fish Habitat

The amended Magnuson-Stevens Act included a new habitat conservation provision known as essential fish habitat (EFH) that requires each existing and any new FMPs to describe and identify EFH for each federally managed species, minimize to the extent practicable impacts from fishing activities on EFH that are more than minimal and not temporary in nature, and identify other actions to encourage the conservation and enhancement of that EFH. To address these requirements the Council has, under separate action, approved an Environmental Impact Statement (GMFMC 2004) to address the new EFH requirements contained within the Magnuson-Stevens Act. Section 305(b)(2) requires federal agencies to obtain a consultation for any action that may adversely affect EFH. An EFH consultation will be conducted for this action.

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APPENDIX B. SUMMARY OF HABITAT UTILIZATION BY LIFE HISTORY STAGE FOR SPECIES IN THE REEF FISH FMP.

Common name	Eggs	Larvae	Early Juveniles	Late juveniles	Adults	Spawning adults
Red Snapper	Pelagic	Pelagic	Hard bottoms, Sand/ shell bottoms, Soft bottoms	Hard bottoms, Sand/ shell bottoms, Soft bottoms	Hard bottoms, Reefs	Sand/ shell bottoms
Queen Snapper	Pelagic	Pelagic	Unknown	Unknown	Hard bottoms	
Mutton Snapper	Reefs	Reefs	Mangroves, Reefs, SAV, Emergent marshes	Mangroves, Reefs, SAV, Emergent marshes	Reefs, SAV	Shoals/ Banks, Shelf edge/slope
Blackfin Snapper	Pelagic		Hard bottoms	Hard bottoms	Hard bottoms, Shelf edge/slope	Hard bottoms, Shelf edge/slope
Cubera Snapper	Pelagic		Mangroves, Emergent marshes, SAV	Mangroves, Emergent marshes, SAV	Mangroves, Reefs	Reefs
Gray Snapper	Pelagic, Reefs	Pelagic, Reefs	Mangroves, Emergent marshes, Seagrasses	Mangroves, Emergent marshes, SAV	Emergent marshes, Hard bottoms, Reefs, Sand/ shell bottoms, Soft bottoms	
Lane Snapper	Pelagic		Mangroves, Reefs, Sand/ shell bottoms, SAV, Soft bottoms	Mangroves, Reefs, Sand/ shell bottoms, SAV, Soft bottoms	Reefs, Sand/ shell bottoms, Shoals/ Banks	Shelf edge/slope
Silk Snapper	Unknown	Unknown	Unknown	Unknown	Shelf edge	
Yellowtail Snapper	Pelagic		Mangroves, SAV, Soft bottoms	Reefs	Hard bottoms, Reefs, Shoals/ Banks	

Common name	Eggs	Larvae	Early Juveniles	Late juveniles	Adults	Spawning adults
Wenchman	Pelagic	Pelagic			Hard bottoms, Shelf edge/slope	Shelf edge/slope
Vermilion Snapper	Pelagic		Hard bottoms, Reefs	Hard bottoms, Reefs	Hard bottoms, Reefs	
Gray Triggerfish	Reefs	Drift algae, *Sargassum*	Drift algae, *Sargassum*	Drift algae, Reefs, *Sargassum*	Reefs, Sand/ shell bottoms	Reefs, Sand/ shell bottoms
Greater Amberjack	Pelagic	Pelagic	Drift algae	Drift algae	Pelagic, Reefs	Pelagic
Lesser Amberjack			Drift algae	Drift algae	Hard bottoms	Hard bottoms
Almaco Jack	Pelagic		Drift algae	Drift algae	Pelagic	Pelagic
Banded Rudderfish		Pelagic	Drift algae	Drift algae	Pelagic	Pelagic
Hogfish			SAV	SAV	Hard bottoms, Reefs	Reefs
Blueline Tilefish	Pelagic	Pelagic			Hard bottoms, Sand/ shell bottoms, Shelf edge/slope, Soft bottoms	
Tilefish (golden)	Pelagic, Shelf edge/ Slope	Pelagic	Hard bottoms, Shelf edge/slope, Soft bottoms	Hard bottoms, Shelf edge/slope, Soft bottoms	Hard bottoms, Shelf edge/slope, Soft bottoms	
Goldface Tilefish	Unknown					
Speckled Hind	Pelagic	Pelagic			Hard bottoms, Reefs	Shelf edge/slope
Yellowedge Grouper	Pelagic	Pelagic		Hard bottoms	Hard bottoms	

Common name	Eggs	Larvae	Early Juveniles	Late juveniles	Adults	Spawning adults
Atlantic Goliath Grouper	Pelagic	Pelagic	Mangroves, Reefs, SAV	Hard bottoms, Mangroves, Reefs, SAV	Hard bottoms, Shoals/ Banks, Reefs	Reefs, Hard bottoms
Red Grouper	Pelagic	Pelagic	Hard bottoms, Reefs, SAV	Hard bottoms, Reefs	Hard bottoms, Reefs	
Warsaw Grouper	Pelagic	Pelagic		Reefs	Hard bottoms, Shelf edge/slope	
Snowy Grouper	Pelagic	Pelagic	Reefs	Reefs	Hard bottoms, Reefs, Shelf edge/slope	
Black Grouper	Pelagic	Pelagic	SAV	Hard bottoms, Reefs	Hard bottoms, Mangroves, Reefs	
Yellowmouth Grouper	Pelagic	Pelagic	Mangroves	Mangroves, Reefs	Hard bottoms, Reefs	
Gag	Pelagic	Pelagic	SAV	Hard bottoms, Reefs, SAV	Hard bottoms, Reefs	
Scamp	Pelagic	Pelagic	Hard bottoms, Mangroves, Reefs	Hard bottoms, Mangroves, Reefs	Hard bottoms, Reefs	Reefs, Shelf edge/slope
Yellowfin Grouper			SAV	Hard bottoms, SAV	Hard bottoms, Reefs	Hard bottoms

Source: Adapted from Table 3.2.7 in the final draft of the EIS from the Generic EFH Amendment (GMFMC 2004a) and consolidated in this document.

APPENDIX C – ANALYSIS OF NATURAL FLUCTUATIONS

On the Probability that the Spawning Stock will Fall Below the Minimum Stock Size Threshold in the Absence of Overfishing

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The Interdisciplinary Planning Team charged with developing a Minimum Stock Size Threshold amendment to the Reef Fish FMP requested an analysis be conducted to determine the likelihood of stock biomass levels falling below the minimum stock size threshold (MSST) for reasons other than overfishing. A preliminary analysis (Porch 2015) suggested that the MSST definition (1-M) B_{MFMT} **,** where M is the natural mortality rate and B_{MFMT} is the spawning stock reference point, might provide a sufficient buffer in cases where fluctuations in recruitment are the primary source of abundance variations. However, it was pointed out that the natural mortality rate might also be expected to fluctuate with time owing to changes in the abundance of predators, episodic red tides and other factors. This document expands on the previous analysis by allowing annual variations in both recruitment and natural mortality. Three stocks with different life history strategies are examined: Vermilion Snapper, Gray Triggerfish and Western Atlantic Bluefin Tuna. These stocks were chosen because the forecasting software used in those assessments was easily modified to accommodate the request. However more species will be analyzed as time permits.

The basic approach to quantifying the probability that a stock would fall below a prescribed level of MSST without undergoing overfishing involves stochastic projections of the long-term abundance of the stock when it is subject to fishing at the maximum fishing mortality threshold (MFMT) used to define the overfishing limit (F_{MSY} for Bluefin, F_{MAX} for Vermilion Snapper and $F_{30\%}$ for Gray Triggerfish). Stochasticity was introduced by incorporating estimates of parameter uncertainty and lognormally-distributed random deviations in recruitment (with estimated standard deviations of approximately 0.3, 0.4 and 0.4 for Bluefin Tuna, Vermilion Snapper, and Gray Triggerfish, respectively) as specified in the assessment documents referenced below. In addition, the natural mortality rate M in each projection year was generated as a uniformly-distributed random variable on the interval 0.5M_{base} to 1.5M_{base}, where M_{base} was the value used in the corresponding stock assessment. Populations were found to reach a dynamic equilibrium within 150 years, therefore it was safe to assume that any transient effects resulting from the stock starting somewhere above or below MSST would be negligible by the final year of the projection. The fraction of the projections where the biomass in the final year falls below the biomass at MSY (or proxy) was then tabulated in the form of cumulative frequency distributions.

When fluctuations in recruitment served as the primary source of population variability, fewer than 5% of the Vermilion Snapper and Gray Triggerfish projections resulted in spawning stock levels below (1- M_{base})B_{MFMT} (Figure 1). In these examples M_{base} was 0.25 and 0.27, respectively, so it was also true that fewer than 5% of the runs resulted in spawning stock levels below 0.75 B_{MFMT}. In the case of Bluefin Tuna, approximately 20% of the runs resulted in spawning stock levels below 0.86 B_{MFMT} and about 6% of the runs fell below 0.75 B_{MFMT} . None of the runs resulted in spawning stock levels below 0.5B_{MFMT}.

When fluctuations in natural mortality were also incorporated in the projections the probability of falling below (1- M_{base}) B_{MFMT} increased substantially (Figure 2). About 5% of the Gray Triggerfish projections and 9% of the Vermilion Snapper projections resulted in spawning stock levels below the fraction (1- M_{base}) of the long-term spawning biomass level associated with MFMT (B_{MFMT}). In the case of Bluefin Tuna, approximately 31% of the runs resulted in spawning stock levels below 0.86 B_{MFMT} and about 15% of the runs fell below 0.75 B_{MFMT} . Less than 1% of the runs for any of the species resulted in spawning stock levels below 0.5B_{MFMT}.

Porch (2015) demonstrated that the probability of classifying a stock as overfished when MSST is defined as (1-*M*) B_{MFMT} changes inversely with the magnitude of *M*. For example, if the value of *M* assumed for Vermilion Snapper is increased from 0.25 to 0.5, the probability that the stock would be classified as overfished decreased from 4% to near zero. Conversely, if the value of *M* assumed for Vermilion Snapper is decreased from 0.25 to 0.05, the probability that the stock would be classified as overfished increased to 37%. The results when annual fluctuations in *M* are included in the projections are consistent with this observation; a 31% chance of falling below (1-*M*) B_{MFMT} for Bluefin, which has an *M* of 0.14, and less than a 10% chance of falling below (1-*M*) B_{MFMT} for Vermillion Snapper and Gray triggerfish, which have *M* values of 0.25 and 0.27, respectively.

The original premise behind the proposal for (1-*M*) B_{MFMT} as a default definition for MSST was that the buffer should somehow decrease with *M* because the extent to which year-class fluctuations result in fluctuations in spawning biomass generally decreases with the number of year classes in the population, and the number of year-classes in the population in turn generally increases with decreasing *M*. However, as shown here, the relationship between variations in spawning biomass and *M* is nonlinear, such that the probability that a stock which is not undergoing overfishing will still dip below the MSST definition (1-*M*) B_{MFMT} increases as *M* decreases. Thus, stocks with low *M* are disproportionately likely to be classified as overfished and require the adoption of rebuilding plans when MSST is defined in this way. On the other hand, the probability of a stock that is not undergoing overfishing falling below 0.75B_{MFMT} was more consistent and relatively low for all species (7%, 9% and 15% for Gray Triggerfish, Vermilion Snapper and Bluefin Tuna, respectively). An implication of this is that a stock which is identified as being below 0.75B_{MFMT} likely did not arrive there owing to random fluctuations and would benefit from a rebuilding plan.

The probability that a stock would fall below an MSST of 0.50B_{MFMT} (the lower limit allowed by NS1) was virtually nil, therefore any stock identified as being below that level almost assuredly did not get there owing to random fluctuations alone. However, as Ortiz et al. (2010) point out, setting a limit so far below B_{MFMT} carries with it the danger of extended time periods for management actions required for rebuilding. In any case, given the current mandate to avoid overfishing, buffers as low as 0.5 B_{MFMT} would appear to have no meaningful effect on the management of moderate to long-lived animals. Based on the results of this work, a buffer of 0.75 B_{MFMT} is recommended for most of the stocks managed in the Southeast region.

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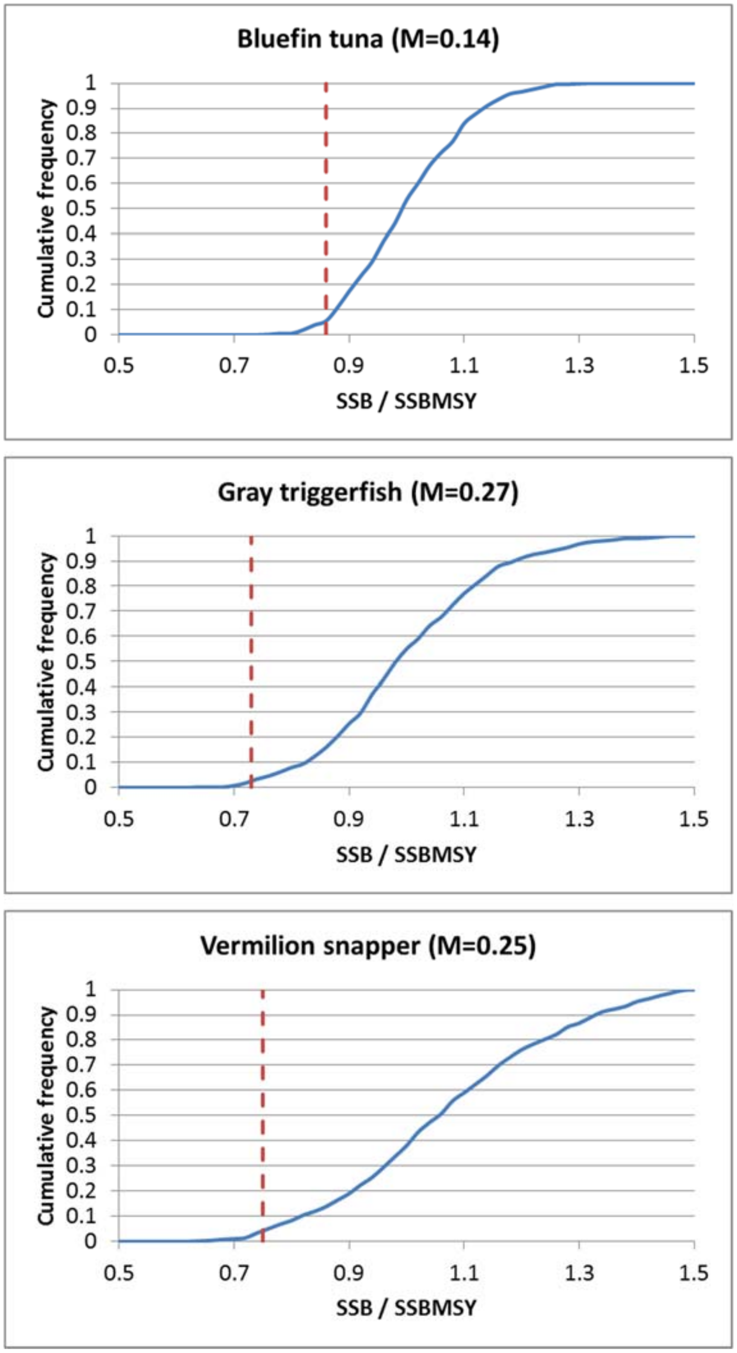

Figure 1. Cumulative probability distributions of the spawning biomass in the last year of the projection relative to the equilibrium spawning biomass associated with MFMT for each of the three species. The dashed vertical line represents the quantity 1-M.

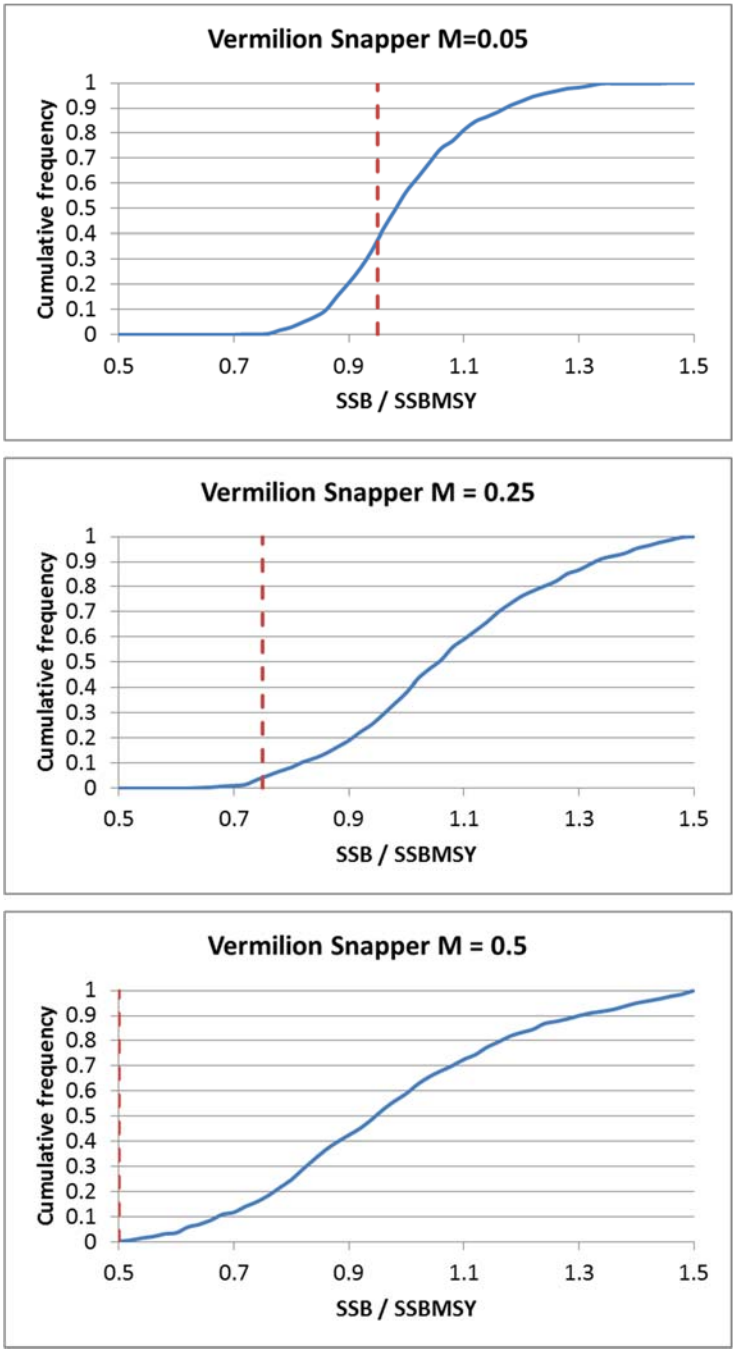

Figure 2. Cumulative probability distributions of the spawning biomass in the last year of the projection relative to the equilibrium spawning biomass associated with MFMT for vermilion snapper assuming 3 different levels of M. The dashed vertical line represents the quantity 1-M.

APPENDIX D – TIME TO RECOVER FROM VARIOUS LEVELS OF MSST

Time to recover from the minimum stock size threshold to the corresponding biomass reference point in the absence of fishing mortality

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Summary

The Gulf of Mexico Fishery Management Council requested an analysis be conducted to determine the minimum time required for a stock to recovery from alternative minimum stock size thresholds (MSST) to the corresponding biomass reference point (biomass equivalent to the equilibrium level if fishing were maintained at the level corresponding to MSY or its proxy, B_{MSY} **).** The candidate MSST definitions are $0.5B_{MSY}$, $0.75B_{MSY}$, $0.85B_{MSY}$, and $0.9B_{MSY}$. Eight stocks with different life history strategies are examined: Yellowfin tuna, Vermilion Snapper, Gray Triggerfish, Red Snapper, King Mackerel, western Atlantic Bluefin Tuna, Gag Grouper and Yellowedge grouper.

The expected time to recovery T_{min} was computed based on projections of the original stock assessment model. The fishing mortality rate in the first few years of the projections was raised or lowered in such a way as to bring the stock to the level of each proposed MSST. After that, the projected fishing mortality rate was set to zero and the number of years required to increase from the MSST to B_{MFMT} was recorded. The results are shown in the table below.

Table 1. Time to recovery from four proposed definitions of MSST

MSST Definition: (% B_{MFMT})	Species							
	Yellowfin tuna	Gray Triggerfish	King Mackerel	Vermilion Snapper	Gag Grouper	Red Snapper	Yellowedge Grouper	Bluefin Tuna
90	1	1	1	1	1	1	1	2
85	1	1	1	1	2	1	2	3
75	1	2	2	2	2	2	3	5
50	3	3	3	3	3	4	6	10

Background

The National Standard Guidelines state that a stock or stock complex is considered "overfished" when its biomass has declined to a level that jeopardizes the capacity of the stock or stock complex to produce MSY on a continuing basis, referred to as the the minimum stock size threshold (MSST). The 2016 revision to the National Standard 1 Guidelines further stipulates that "the level of MSST should be between ½ Bmsy and Bmsy, and could be informed by the life history of the stock, *the natural fluctuations in biomass associated with fishing at MFMT over the long-term*, the requirements of internationally-managed stocks, or other considerations. [Emphasis ours]" In regard to natural fluctuations, Porch (2016) showed that the probability that a stock will fall below $0.75B_{MSY}$ when it is not undergoing overfishing owing to random fluctuations in recruitment and natural mortality was low for the species examined: 7%, 9% and 15% for Gray triggerfish, Vermilion snapper and Bluefin tuna, respectively. An implication of this is that a stock which is identified as being below $0.75B_{MSY}$ likely did not arrive there by chance and would benefit from a rebuilding plan. The probability that a stock would fall below an MSST of $0.50B_{MFMT}$ (the lower limit allowed by NS1) was virtually nil, therefore any stock identified as being below that level almost assuredly did not get there owing to random fluctuations alone. However, as Ortiz et al. (2010) point out, setting a limit so far below B_{MFMT} carries with it the danger of extended time periods for management actions required for rebuilding.

The 2016 revision to the National Standard 1 Guidelines also stipulate that "where a stock or stock complex is declared overfished, the Council must specify a time period for rebuilding the stock or stock complex based on factors specified in Magnuson-Stevens Act section 304(e)(4). This target time for rebuilding (T_{target}) shall be as short as possible, taking into account: the status and biology of any overfished stock, the needs of fishing communities, recommendations by international organizations in which the U.S. participates, and interaction of the stock within the marine ecosystem. In addition, the time period shall not exceed 10 years, except where biology of the stock, other environmental conditions, or management measures under an international agreement to which the U.S. participates, dictate otherwise." This stipulation implies that another potential metric for determining the most appropriate definition of MSST is the minimum time to rebuild to $B_{MSY.}$

This paper addresses a request from the Gulf of Mexico Fishery Management Council to determine the time required for a stock to recovery from alternative minimum stock size thresholds (MSST) to B_{MSY} with no fishing. The candidate MSST definitions are $0.5B_{MSY}$, $0.75B_{MSY}$, $0.85B_{MSY}$, and $0.9B_{MSY}$.

Methods, Results and Discussion

Eight stocks with different life history strategies are examined: Yellowfin tuna, Vermilion Snapper, Gray Triggerfish, Red Snapper, King Mackerel, western Atlantic Bluefin Tuna, Gag Grouper and Yellowedge grouper. The expected time to recovery T_{min} was computed based on projections of the original stock assessment models (for details see references for each species below). The fishing mortality rate in the first few years of the projections was raised or lowered in such a way as to bring the stock to the level of each proposed MSST. After that, the projected fishing mortality rate was set to zero and the number of years required to increase from the MSST to B_{MSY} was recorded.

The results are shown in Table 1 above. As might be expected, the rate of recovery depended mostly on the generation time and the extent of compensatory mortality in the spawner-recruit relationship. Early maturing, fast growing species like vermilion snapper, king mackerel and yellowfin tuna were able to double their spawning potential in only 3 years, whereas later maturing species like yellowedge grouper and bluefin tuna required 6 and 10 years, respectively. For all species a full recovery to B_{MSY} was possible within 10 years even if the stock had been depleted to 50% of B_{MSY}. Therefore, based on recovery rates alone, the limit of 50% B_{MSY} prescribed by NS1 could be considered appropriate for most if not all species in the Gulf of Mexico FMP. However, it is important to recognize that in many of the assessments examined here the relationship between spawning potential and the number of recruits was poorly determined and often assumed to be weak in the projections (i.e., high steepness, low compensatory mortality). The rate of recovery is generally slower as the degree of compensatory mortality increases (steepness decreases), especially at lower levels of depletion (as seen in the Bluefin Tuna example). Futhermore, it is difficult in practice to completely eliminate all sources of fishing mortality for any given species. If some level of undirected fishing mortality continued, then recovery would be slower than projected here. Finally, as shown in Porch (2016), there is very little chance that spawning potential levels would fall below 75% B_{MSY} unless overfishing had been occurring (Figure 1). Thus, it would seem inconsistent to wait until the stock had decreased to well below 75% B_{MSY} to declare it overfished.

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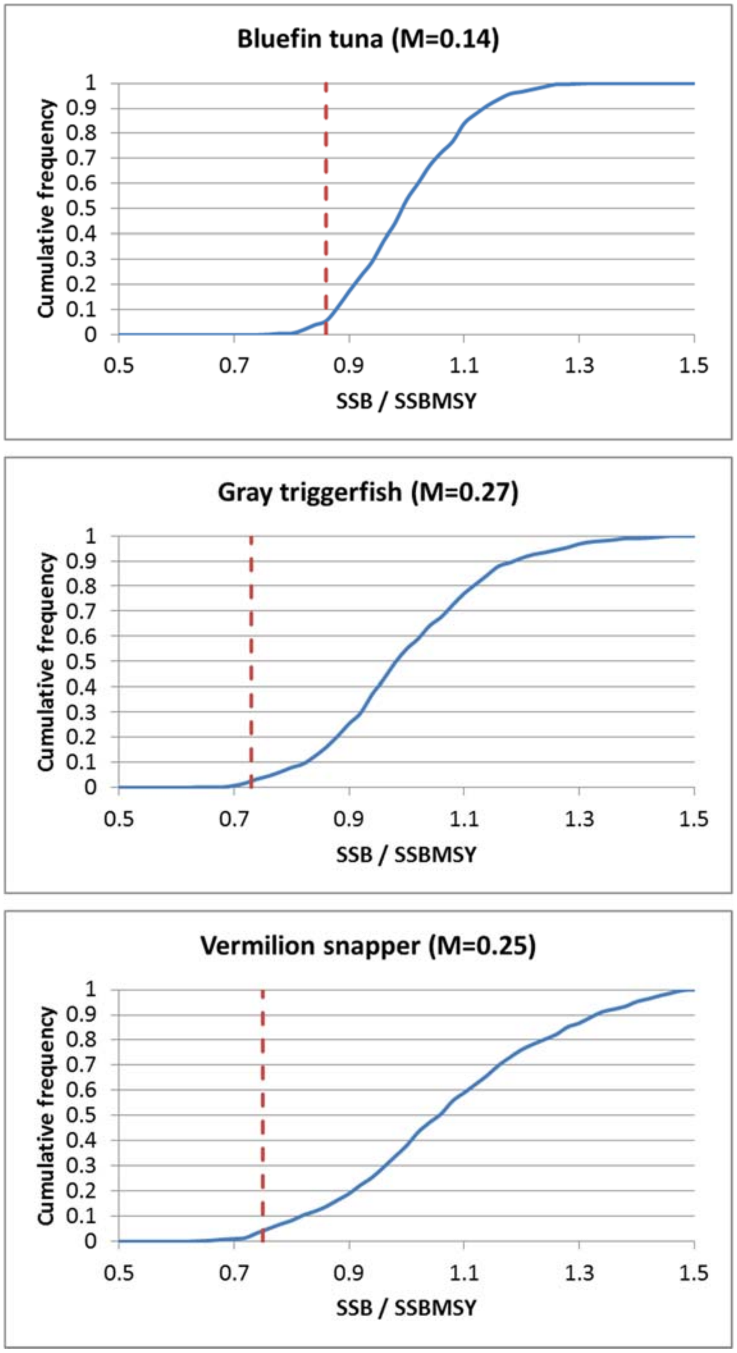

Figure 1. Cumulative probability distributions of the spawning biomass in the last year of the projection relative to the equilibrium spawning biomass associated with MSY for each of the three species. The dashed vertical line represents the quantity 1-M. Reproduced from Porch (2016).

APPENDIX E – SUMMARY OF COMMENTS RECEIVED